FLOOD INSURANCE STUDY

VOLUME 1 OF 2

OTTAWA COUNTY, MICHIGAN

(ALL JURISDICTIONS)

Community Name	Community Number
Allendale, Charter Township of	260490
* Blendon, Township of	261005
Chester, Township of	260829
Coopersville, City of	260491
Crockery, Township of	260981
Ferrysburg, City of	260184
Georgetown, Charter Township of	260589
Grand Haven, City of	260269
Grand Haven, Charter Township of	260270
Holland, City of (Allegan and Ottawa Counties)	260006
Holland, Charter Township of	260492
Hudsonville, City of	260493
Jamestown, Charter Township of	261001
* Olive, Township of	261006
Park, Township of	260185
Polkton, Charter Township of	260923
Port Sheldon, Township of	260278
Robinson, Township of	260913
Spring Lake, Township of	260281
Spring Lake, Village of	260282
Tallmadge, Charter Township of	260494
Wright, Township of	260495
Zeeland, Charter Township of	260932
Zeeland, City of	260983

* No Special Flood Hazard Areas identified

REVISED:
May 16, 2013

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
26139CV001B

NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program have established repositories of flood hazard data for floodplain management and flood insurance purposes. This Flood Insurance Study (FIS) report may not contain all data available within the Community Map Repository. It is advisable to contact the Community Map Repository for any additional data.

The Federal Emergency Management Agency (FEMA) may revise and republish part or all of this FIS at any time. In addition, FEMA may revise part of this FIS report by the Letter of Map Revision (LOMR) process, which does not involve republication or redistribution of the FIS report. Therefore, users should consult with community officials and check the Community Map Repository to obtain the most current FIS report components.

Initial Countywide FIS Effective Date: December 16, 2011

Revised Countywide FIS Date: May 16, 2013

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FLOOD INSURANCE STUDY

OTTAWA COUNTY, MICHIGAN (ALL JURISDICTIONS)

1.0 INTRODUCTION

1.1 Purpose of Study

This countywide Flood Insurance Study (FIS) revises and supersedes the FIS reports, Flood Insurance Rate Maps (FIRMs) and/or Flood Boundary and Floodway Maps (FBFMs) in the geographic area of Ottawa County, including the Charter Townships of Allendale, Georgetown, Grand Haven, Holland, Jamestown, Polkton, Tallmadge, and Zeeland, the Cities of Coopersville, Ferrysburg, Grand Haven, Holland, Hudsonville, and Zeeland; the Townships of Blendon, Chester, Crockery, Olive, Park, Port Sheldon, Robinson, Spring Lake, and Wright, and the Village of Spring Lake (hereinafter referred to collectively as Ottawa County), and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. Please note that the Townships of Blendon and Olive have no Special Flood Hazard Areas (SFHAs) identified. The City of Holland is located in both Allegan and Ottawa Counties and is included in its entirety in this FIS. The Charter Townships of Grand Haven, Holland, and Tallmadge were previously referred to as the Townships of Grand Haven, Holland, and Tallmadge. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates. This information will also be used by Ottawa County to update existing floodplain regulations as part of the Regular Phase of the National Flood Insurance Program (NFIP), and to assist the community in its efforts to promote sound floodplain management. Minimum floodplain management requirements for participation in the National Flood Insurance Program (NFIP) are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some states or communities, floodplain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum federal requirements. In such cases, the more restrictive criteria take precedence and the state (or other jurisdictional agency) will be able to explain them.

The Digital Flood Insurance Rate Map (DFIRM) and FIS Report for this countywide study have been produced in digital format. Flood hazard information was converted to meet the Federal Emergency Management Agency (FEMA) DFIRM database specifications and Geographic Information System (GIS) format requirements. The flood hazard information was created and is provided in a digital format so that it can be incorporated into a local GIS and be accessed more easily by the community.

1.2 Authority and Acknowledgments

The sources of authority for this countywide FIS are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

Information on the authority and acknowledgments for each of the previously printed FISs and FIRMs for communities within Ottawa County was compiled and is shown below.

Charter Township of Allendale	The hydrologic and hydraulic analyses for the FIS report and FIRM dated July 5, 1982, were performed by Grove Associates, Inc., (Grove Associates) for FEMA, under Contract No. H-4728. This work was completed in July 1981 (Reference 1).
Charter Township of Georgetown	The hydrologic and hydraulic analyses for the FIS report and FIRM dated February 5, 1992, were performed by the U.S. Army Corps of Engineers (USACE), Detroit District, for FEMA, under Inter-Agency Agreement No. EMW-89-E-2978, Project Order No. 2. This work was completed in November 1989 (Reference 2).
Charter Township of Grand Haven	The hydrologic and hydraulic analyses for the FIS report dated July 16, 1980, and FIRM dated January 16, 1981, were performed by Commonwealth Associates, Inc., for the Federal Insurance Administration (FIA), under Contract No. H-4537. This work was completed in December 1978. Please note that the Charter Township of Grand Haven was referred to as the Township of Grand Haven at the time of this study (Reference 8).
Charter Township of Holland	The hydrologic and hydraulic analyses for the FIS report and FIRM dated September 28, 1990, were performed by the USACE, Detroit District, for FEMA, under Inter-Agency Agreement No. EMW-87-E-2509, Project Order No. 9. This work was completed in March 1988. Please note that the Charter Township of Holland was referred to as the Township of Holland at the time of this study (Reference 9).
Charter Township of Tallmadge	The hydrologic and hydraulic analyses for the FIS report dated September 2, 1982, and FIRM dated March 2, 1983, were performed by Grove Associates for FEMA, under Contract No. H-4728. This work was completed in February 1981. Please note that the Charter Township of Tallmadge was referred to as the Townhip of Tallmadge at the time of this study (Reference 13).
City of Coopersville	The hydrologic and hydraulic analyses for the FIS report dated September 2, 1982, and FIRM dated March 2, 1983, were performed by Grove Associates, for FEMA, under Contract No. H-4728. This work was completed in April 1981 (Reference 3).
City of Ferrysburg	The hydrologic and hydraulic analyses for the FIS report dated August 1977 and the FIRM dated March 1, 1978, were performed by Johnson & Anderson, Inc., (Johnson & Johnson) for the FIA, under Contract No. H-3816. This work was completed in January 1977 (Reference 4).

City of Grand Haven	The hydrologic and hydraulic analyses for the FIS report dated May 1977 and the FIRM dated February 15, 1978, were performed by Johnson & Anderson, for the FIA, under Contract No. H-3816. This work was completed in March 1977 (Reference 5).
City of Holland	The hydrologic and hydraulic analyses for the FIS report and FIRM dated September 28, 1990, were performed by the USACE, Detroit District, for FEMA, under Inter-Agency Agreement No. EMW-87-E-2509, Project Order No. 10. This work was completed in February 1988 (Reference 6).
City of Hudsonville	The hydrologic and hydraulic analyses for the FIS report dated June 4, 1984, and FIRM dated December 4, 1984, were performed by Grove Associates for FEMA, under Contract No. H-4728. This work was completed in March 1983 (Reference 7).
Township of Park	The hydrologic and hydraulic analyses for the FIS report dated November 1977 and FIRM dated May 15, 1978, were performed by Johnson & Anderson, for the FIA, under Contract No. H-3816. This work was completed in April 1977 (Reference 10).
Township of Port Sheldon	The hydrologic and hydraulic analyses for the FIS report dated November 1977 and FIRM dated May 15, 1978, were performed by Johnson & Anderson, for the FIA, under Contract No. H-3816. This work was completed in March 1977 (Reference 11).
Township of Spring Lake	The hydrologic and hydraulic analyses for the FIS report dated May 1977 and FIRM dated February 15, 1978, were performed by Johnson & Anderson, for the FIA, under Contract No. H-3816. This work was completed in January 1977 (Reference 12).
Village of Spring Lake	The hydrologic and hydraulic analyses for the FIS report dated December 1977 and FIRM dated June 1, 1978, were performed by Johnson & Anderson, for the FIA, under Contract No. H-3816. This work was completed in January 1977 (Reference 14).

Flood hazards in the Township of Chester were previously studied by approximate methods. The 1-percent-annual-chance floodplain boundaries are shown on a FIRM dated November 20, 1991 (Reference 15).

There are no previously printed FIS reports for the Charter Townships of Jamestown, Polktown, and Zeeland, the City of Zeeland, or the Townships of Blendon, Chester, Crockery, Olive, Robinson, and Wright.

Detailed hydrologic and hydraulic analyses for portions of the Grand River and the Macatawa River / Black Creek of Zeeland Drain were performed by the Geological and Land Management Division of the Michigan Department of Environmental Quality (MDEQ) for FEMA under Contract No. H-1983. This work was completed in January 2001 (References 16 and 17).

Detailed hydrologic and hydraulic analyses were performed by Spicer Group, Inc., (Spicer Group) as a Special Problem Report (SPR) under Cooperating Technical Partners (CTP) Mapping Activity Statement (MAS) 2004-01. This work covered portions of Alward Drain, Bareman Drain, Bliss Creek Intercounty Drain, Bliss Creek Intercounty Drain Diversion Channel, Buttermilk Drain, County Drain No. 8 and North Holland Drain, County Drain No. 15 & 17, County Drain No. 28, County Drain No. 40, DeWeerd Drain, Huizenga Intercounty Drain, Knight Intercounty Drain, Meadowbrook Drain, Northwest Branch of Rush Creek, Rush Creek, Trout Drain, Unnamed Tributary 1 to Buttermilk Creek, Unnamed Tributary 2 to Buttermilk Creek, Vans Bypass, and Windmill Creek. This work was completed in 2007 (References 18–38).

The hydraulic analysis prepared by Spicer Group for Bareman Drain as part of the SPR completed under CTP MAS 2004-01 was revised in order to more accurately reflect the geometry of the culvert located immediately downstream of US 31 that passes below Felch Plaza. This work, which was completed in 2010, was performed by Exxel Engineering, Inc., (Exxel Engineering) as part of an appeal filed in September 2010 by the Holland Charter Township Community Development Department.

The approximate hydrologic and hydraulic analyses for this study were performed by Stantec Consulting Services, Inc., (Stantec) for FEMA in two phases. Work on Phase I was performed under Contract No. EMC-2001-CO-0057 and included Beaver Creek, Black Creek, Black Creek of Zeeland Drain, Brandy Creek, Crockery Creek, and Deer Creek. Work on Phase II was performed under Contract No. HSFE05-05-D-0026 and included Averill Drain, Crockery Lake Tributary, East Fork Sand Creek, Jackson & Gilbert Drain, Morley Drain, North Branch Crockery Creek, North Branch Crockery Creek Tributary, Rio Grande Creek, Sand Creek, No. 37 Drain, No. 53 Drain, and Upper North Branch Crockery Creek Tributary. Work performed under Phases I and II was completed in May 2005 and March 2006, respectively. This work covered unprotected flooding sources affecting Ottawa County.

In addition to incorporating the existing 14 FISs for communities within Ottawa County, this countywide FIS includes approximate and detailed studies, redelineation of all other effective profiles and incorporation of approved Letters of Map Change (LOMCs). The vertical datum was shifted to North American Vertical Datum of 1988 (NAVD88). The digital floodplain data was merged into a single updated DFIRM. The DFIRM includes 2003 digital orthophotography, 2-foot contours, topographic break lines and spot elevations, political boundaries, road centerlines with street names, railroads with names, airports, rivers, lakes, streams, bridges and other hydraulic structures, and elevation reference marks. The coordinate system used for the production of the digital FIRMs is State Plane Michigan South Zone 2113 referenced to the North American Datum of 1983 and the Geodetic Reference System 1980 ellipsoid.

May 16, 2013
Revised Countywide FIS

For the May 16, 2013, revision, the revised hydraulic analysis of the Grand River was performed by Strategic Alliance for Risk Reduction (STARR) for FEMA under Contract No. HSFE05-10-J-0005, Task Order No. 5. This work was completed in August 2011. The analysis performed by STARR is based on a hydraulics model prepared by Exxel Engineering in 2009 as part of LOMR 09-05-5087P.

1.3 Coordination

The purpose of an initial Consultation Coordination Officer's (CCO's) meeting is to discuss the scope of the FIS. A final CCO meeting is held to review the results of the study. The dates of the initial and final CCO meetings held for the previous FISs for the incorporated communities within Ottawa County's boundaries are shown in TABLE 1 (References 1–14).

TABLE 1 – Ottawa County CCO Meetings

Community Name	Initial CCO Date	Final CCO Date
Allendale, Charter Township of	November 10, 1978	February 9, 1982
Coopersville, City of	November 1, 1978	February 8, 1982
Ferrysburg, City of	not published	February 24, 1977
Georgetown, Charter Township of	June 8, 1988	March 13, 1991
Grand Haven, City of	not published	February 24, 1977
Grand Haven, Charter Township of	May 3, 1977	November 27, 1979
Holland, City of	September 10, 1986	September 19, 1989
Holland, Charter Township of	September 10, 1986	September 19, 1989
Hudsonville, City of	November 1, 1978	November 21, 1983
Park, Township of	not published	June 22, 1977
Port Sheldon, Township of	not published	June 22, 1977
Spring Lake, Township of	not published	February 24, 1977
Spring Lake, Village of	not published	February 24, 1977
Tallmadge, Charter Township of	November 10, 1978	February 9, 1982

Results of the technical aspects of this study were coordinated with and reviewed and approved by MDEQ, the state coordinating agency.

On September 5, 2003, an initial CCO meeting was held concerning the 2011 countywide FIS. This meeting was attended by representatives of FEMA, MDEQ, USACE, other local participants, and the study contractor.

The results of the 2011 study were reviewed at the final CCO meeting held on August 8, 2009, and attended by representatives of FEMA, the community, and the study contractor. All problems raised at that meeting were addressed.

May 16, 2013
Revised Countywide FIS

In 2010, STARR was contracted by FEMA Region V to incorporate LOMR 09-05-5087P as a Physical Map Revision (PMR) for Ottawa County. STARR reviewed the hydraulics model prepared for LOMR 09-05-5087P and determined that the computed water-surface elevations at the downstream limit of study exceeded the water-surface elevations presented in the effective countywide FIS for Ottawa County dated December 16, 2011, (Reference 68) by nearly 1 foot. In August 2011, FEMA approved a Change Request for STARR to modify the hydraulic model submitted with LOMR 09-05-5087P in order for it to tie in seamlessly with the effective SFHAs. This revised study was incorporated as part of the May 16, 2013, revision. A final CCO meeting was not held for this revision.

2.0 AREA STUDIED

2.1 Scope of Study

This countywide FIS covers the geographic area of Ottawa County, Michigan, as well as the portion of the City of Holland located in Allegan County, Michigan.

Several streams in this countywide FIS have names that differ from those used in the previously printed FISs for the communities within Ottawa County. These name changes are listed in TABLE 2.

TABLE 2 – Stream Name Changes

Community	Old Name	New Name
Allendale, Charter Township of	Ottawa Creek	Ottawa Creek & Ext. Drain / Ottawa Drain / Curry Drain
Georgetown, Charter Township of	Bliss Drain	Bliss Creek Intercounty Drain
	Bliss Drain Diversion Channel	Bliss Creek Intercounty Drain Diversion Channel
	Huizenga Drain	Huizenga Intercounty Drain
	Lowing-Comstock Drain	Comstock Drain
	Lowing-Comstock Drain Tributary	Hager Creek
Holland, Charter Township of	Brower Drain (Upstream of 104th Avenue)	Brower & No. 39 Drain
	Brower Drain / County Drain No. 20	Hunters Creek
	Pine Creek	Harlem Drain
	Macatawa River	Black Creek of Zeeland Drain

TABLE 2 – Stream Name Changes *(continued)*

Community	Old Name	New Name
Holland, City of	Macatawa River	Black Creek of Zeeland Drain[1]
Park, Township of	Pine Creek	Harlem Ext. Drain
Zeeland, Charter Township of	Macatawa River	Black Creek of Zeeland Drain[1]

1 Upstream of 120th Avenue

The flooding sources studied previously by detailed methods that have been incorporated into this countywide FIS are shown in TABLE 3. The limits of detailed study for streams are described from downstream to upstream (References 1–14).

TABLE 3 – Limits of Previous Detailed Studies

Flooding Source	Limits of Detailed Study
Brower & No. 39 Drain	From confluence with Hunters Creek to 100th Avenue
Comstock Drain	From confluence with Grand River to a point approximately 770 feet upstream of 28th Avenue
Deer Creek	From westbound Interstate 96 to the City of Coopersville / Charter Township of Polktown corporate limits
Grand River	From mouth at Lake Michigan a point approximately 0.4 mile downstream of the Township of Spring Lake / Township of Crockery and Township of Robinson / Charter Township of Grand Haven corporate limits, and from a point approximately 4.4 miles upstream of Lake Michigan Drive to the Ottawa / Kent County boundary
Hager Creek	From confluence with Comstock Drain to a point approximately 1,820 feet upstream of 28th Avenue
Harlem Ext. Drain / Harlem Drain	From mouth at Pine Creek Bay to Quincy Street
Hunters Creek	From confluence with Noordeloos Creek to a point approximately 25 feet upstream of 100th Avenue
Noordeloos Creek	From confluence with Black Creek of Zeeland Drain to Quincy Street
Ottawa Creek & Ext. Drain / Ottawa Drain / Curry Drain	From confluence with Grand River to a point approximately 0.8 mile upstream of Radcliff Drive
South Channel	From confluence with Grand River to divergence with Grand River
Tulip Intercounty Drain	From confluence with Black Creek of Zeeland Drain to Country Club Road
Watson Drain	From confluence with Grand River to 12th Avenue

TABLE 3 – Limits of Previous Detailed Studies *(continued)*

Lakes and Bayous

Black Lake	Lloyd's Bayou	Pottawattomie Bayou
Cedar Lake East	Mill House Bayou	Spring Lake
Lake Macatawa	Pigeon Lake	

Detailed studies performed by MDEQ, Exxel Engineering, Spicer Group, and the USACE were incorporated into the countywide FIS published December 16, 2011. For the May 16, 2013, revision, a revised detailed hydraulic analysis performed by STARR for a reach of the Grand River. The newly studied and restudied flooding sources are shown in TABLE 4. The limits of detailed study for streams are described from downstream to upstream (References 18, 19, and 28–38).

TABLE 4a – Limits of New and Restudied Detailed Studies –
December 16, 2011, Initial Countywide FIS

Flooding Source	Limits of Detailed Study
Alward Drain	From the confluence with Rush Creek to a point approximately 80 feet upstream of 36th Avenue
Bareman Drain	From the confluence with County Drain No. 15 & 17 to a point approximately 80 feet upstream of Quincy Street
Bliss Creek Intercounty Drain	From the confluence with Rush Creek to the confluence with Knight Intercounty Drain
Bliss Creek Intercounty Drain Diversion Channel	From the confluence with Bliss Creek Intercounty Drain (at a point on Bliss Creek Intercounty Drain approximately 1,450 feet downstream of Wisner Street) to the divergence from Bliss Creek Intercounty Drain (at a point on Bliss Creek Intercounty Drain approximately 1,610 feet upstream of Wisner Street)
Buttermilk Creek	From the confluence with Rush Creek to a point approximately 160 feet upstream of Quincy Street
County Drain No. 8 and North Holland Drain	From the confluence with County Drain No. 15 & 17 and County Drain No. 40 to a point approximately 135 feet upstream of Quincy Street
County Drain No. 15 & 17	From the confluence with County Drain No. 8 and North Holland Drain and County Drain No. 40 to a point approximately 55 feet upstream of the divergence of Vans Bypass
County Drain No. 28	From the confluence with County Drain No. 40 and Windmill Creek to a point approximately 120 feet upstream of James Street
County Drain No. 40	From the confluence with County Drain No. 28 and Windmill Creek to the confluence with County Drain No. 8 and North Holland Drain and County Drain No. 15 & 17

TABLE 4a – Limits of New and Restudied Detailed Studies –
December 16, 2011, Initial Countywide FIS *(continued)*

Flooding Source	Limits of Detailed Study
DeWeerd Drain	From the confluence with Rush Creek to the Rush Creek Phase III Dam
Grand River	From a point approximately 0.4 mile downstream of the Township of Spring Lake / Township of Crockery and Township of Robinson / Charter Township of Grand Haven corporate limits to a point approximately 0.8 mile downstream of the westbound Lake Michigan Drive bridge
Huizenga Intercounty Drain	From the confluence with Rush Creek to Kenowa Avenue
Knight Intercounty Drain	From the confluence with Bliss Creek Intercounty Drain to Kenowa Avenue
Macatawa River / Black Creek of Zeeland Drain	From the mouth at Lake Macatawa to Felch Street
Meadowbrook Drain	From the confluence with Bliss Creek Intercounty Drain to a point approximately 620 feet upstream of 8th Avenue
Northwest Branch of Rush Creek	From the confluence with Rush Creek at 40th Avenue to the Rush Creek Phase I Dam
Rush Creek	From the Kent / Ottawa County boundary to the confluence with Northwest Branch of Rush Creek at 40th Avenue
Trout Drain	From the confluence with DeWeerd Drain to a point approximately 315 feet west of 22nd Avenue
Unnamed Tributary 1 to Buttermilk Creek	From the confluence with Buttermilk Creek to a point approximately 105 feet upstream of Northbound Interstate 196
Unnamed Tributary 2 to Buttermilk Creek	From the confluence with Buttermilk Creek to Quincy Street
Vans Bypass	From the confluence with Bareman Drain to the divergence with County Drain No. 15 & 17
Windmill Creek	From the confluence with Macatawa River to the confluence with County Drain No. 28 and County Drain No. 40

Lakes

Creekside Lake	Lake Michigan	Waterfront Lake
East Georgetown Shores Lake	Morning Dew Lake	West Georgetown Shores Lake
	Rushmore Lake	

TABLE 4b – Limits of New and Restudied Detailed Studies –
May 16, 2013, Revised FIS

Flooding Source	Limits of Detailed Study
Grand River	From a point approximately 0.8 mile downstream of the westbound Lake Michigan Drive bridge to a point approximately 4.4 miles upstream of Lake Michigan Drive

Approximate analyses are usually used to study areas having a low development potential or minimal flood hazards. As part of the December 16, 2011, FIS, the floodplains for streams previously studied by approximate methods were redelineated based on updated topographic data. Additional approximate analyses were performed to protect areas where flood hazards were not previously identified. These additional areas include portions of the streams listed in Section 1.2, as well as Bay Meadows Lake, Hidden Lake, Little Black Lake, Pinewood Lake, Silver Ridge Lake, Skipping Stone Lake, Trillium Lake, and West Cedar Lake.

This countywide FIS also incorporates the determination of letters issued by FEMA resulting in map revisions (Letters of Map Revision (LOMRs)), as shown in TABLE 5.

TABLE 5a – Letters of Map Changes
December 16, 2011, Initial Countywide FIS

Community	Case Number	Type	Flood Source(s)	Determination Date
Park, Township of	04-05-0766P	LOMR	No. 53 and Silver Ridge Lake	August 9, 2004
Grand Haven, City of	00-05-297P	LOMR	Grand River	October 26, 2000
Georgetown, Charter Township of	11-05-3623P	LOMR	Grand River	June 6, 2011

TABLE 5b – Letters of Map Changes
May 16, 2013, Revised FIS

Community	Case Number	Type	Flood Source(s)	Determination Date
Allendale, Charter Township of; Georgetown, Charter Township of; and Tallmadge, Charter Township of	09-05-5087P	LOMR	Grand River	May 28, 2010

Letters of Map Amendment (LOMAs) incorporated for this study are summarized in the Summary of Map Actions (SOMA) included in the Technical Support Data Notebook (TSDN) associated with this FIS update. Copies of the SOMA may be obtained from the Community Map Repository. Copies of the TSDN may be obtained from FEMA.

2.2 Community Description

Ottawa County is located in the southwestern portion of the lower peninsula of Michigan and encompasses a total area of approximately 565 square miles. It is bounded on the north by Muskegon County, on the east by Kent County, on the south by Allegan County, and on the west by Lake Michigan. The major transportation arteries serving Ottawa County include Interstate 96, Interstate 196, M-6, M-11, M-45, M-104, M-121, and US 31, as well as Chesapeake and Ohio Railway, Conrail Railroad, and Grand Trunk Western Railroad.

Ottawa County is currently the fastest growing of all Michigan counties with populations over 200,000. According to U.S. Census Bureau figures, the April 1, 2000, population of Ottawa County was 238,314. The estimated July 1, 2009, population was 261,957, an increase of 9.9 percent from the April 1, 2000, population figure. There are three major urbanized areas in the county: an area in southwestern Ottawa County centered about the Cities of Holland and Zeeland; the tri-cities area in northwestern Ottawa County consisting of the Cities of Ferrysburg and Grand Haven and the Village of Spring Lake; and an area near the Ottawa / Kent County boundary in western Ottawa County in the vicinity of the City of Grand Rapids (References 41 and 42).

Ottawa County's climate is influenced appreciably by Lake Michigan due to its proximity and prevailing westerly winds. During the spring, the cooling effect of the lake results in lower temperatures and retards the growth of vegetation. During the fall, the warming effect of the lake maintains higher temperatures and prolongs the growing season. Winter and summer temperatures are similarly tempered by the lake. Average temperatures vary from a mean monthly maximum of 71 degrees Fahrenheit (F) in July to a mean monthly minimum of 25 degrees F in January, with a mean annual temperature of 49 degrees F. The mean annual precipitation is approximately 36 inches, which includes the mean annual snowfall of approximately 78 inches. Precipitation is typically well distributed throughout the year (Reference 43).

The topography of Ottawa County is fairly uniform, varying from undulating to moderately hilly. Surface features are mostly the result of glacial action. The total relief for the county is slightly more than 800 feet (Reference 42).

Three well-defined topographic divisions are seen in the Ottawa County. The first division is a broad, low-lying sandy plain in the western half of the county. Next is a gently-sloping to hilly upland in the southeastern portion of the county. The third division is a gently-sloping to rolling upland plain found in the northeastern corner of the county (Reference 42).

Twelve soil associations are found in Ottawa County. Sandy soils are prevalent. Approximately 47 percent of the county has predominantly sand soil, 29 percent has loamy soil, 17 percent has sandy-loamy mix, 4 percent has bottomland solids and organic matter mix, and 3 percent has a gravel-sand mix (Reference 42).

Over three quarters of Ottawa County is drained by the Grand River watershed. The southwestern portion of the county is drained by the Macatawa River watershed. A small area in southeastern Ottawa County is drained by the Kalamazoo River watershed.

Nearly one half of the area of Ottawa County is used for agricultural purposes. Forest areas, the second largest category of land use within the county, occupy between one-fifth and one-quarter of the county's area. The area of each of these land uses has been decreasing in recent years. Urban land use is the next largest category and has been increasing in area. In 1991, urban land use accounted for more than 15 percent of the county's area (Reference 42).

2.3 Principal Flood Problems

The principal flooding problems in Ottawa County occur when high runoff causes streams and lakes to overflow their banks. This is seen on the Bass River, Buttermilk Creek, Deer Creek, the Grand River, Lake Macatawa, Lake Michigan, Lloyds Bayou, the Macatawa River / Black Creek of Zeeland Drain, Ottawa Creek, Pigeon Lake, Pine Creek, Rush Creek, and Spring Lake, as well as a number of other smaller streams. Flooding along the Grand River and the Macatawa River / Black Creek of Zeeland Drain has historically caused the most damage (References 1–14).

High water levels on Lake Michigan cause problems in the communities along the lakeshore. Flooding on Lake Michigan may be caused by both long- and short-term events. Long-term fluctuations are caused by runoff throughout the entire Great Lakes Basin. The response time of the Great Lakes to this runoff is approximately two years. Short-term flooding is commonly caused by wind tides, storm surges, barometric changes, and seiching. Short-term fluctuations can cause flooding within a few hours (References 4–6, 8, and 10–12).

Flooding in the spring often results from a combination of snowmelt, rainfall runoff, and ice jams. The largest recorded flooding event on the Grand River occurred as a result of this combination in March 1904. The peak flow approached the 1-percent-annual-chance discharge. Flooding from this event lasted approximately 10 days (References 1, 2, 4, 5, and 12–14).

The second largest recorded flood event on the Grand River occurred a year later in June 1905 as a result of heavy rainfall. A minimum of 2.53 inches of rainfall was measured in the City of Grand Haven. The river crested at an elevation within 0.9 foot of the March 1904 flood elevation (References 1, 2, 4, 5, and 12–14).

During the two-day period of May 10–11, 1981, over 5 inches of rain fell, which led to significant flooding in the southern portion of Ottawa County. In the Charter Township and City of Holland, numerous roads were flooded, including 24th Street between Waverly and County Club Roads; Pine Avenue in front of the James De Young Generating Station; Van Bragt Park near River Avenue; and US 31 at New Holland Street, Quincy Street, and Riley Street. Portions of Greenly Street and Quincy Street were inundated by 6 to 12 inches of water. Also during this event, the Paw Paw Drive bridge across Black Creek of Zeeland Drain was damaged by high water (Reference 42).

Significant flooding also occurred in the Charter Township and City of Zeeland during the May 10–11, 1981, event. Paw Paw Drive between Chicago Drive and 104th Avenue was flooded and 96th Avenue at Quincy Street was under 2 feet of water. Numerous basements were flooded as a result of a sewer lift station that was flooded when it could not handle the large quantity of floodwater (Reference 42).

In other parts of Ottawa County, Chicago Drive was flooded by Black Creek of Zeeland Drain from the City of Zeeland upstream to the City of Hudsonville during the May 10–11, 1981, event. Chicago Drive was also flooded by Rush Creek in the Charter Township of Georgetown at Port Sheldon Road (Reference 42).

Eleven inches of rainfall occurred on July 17–18, 1982, which caused significant flooding in southwestern Ottawa County. At one point, US 31 was closed south of 32nd Street. In the City of Holland, basements in homes along 24th Street between Fairbanks Avenue and Lincoln Avenue were inundated. Several streets remained closed on July 19 due to high water and damage (Reference 42).

On September 10, 1986, 8 to 17 inches of rain fell over a 24-hour period across the middle of the lower peninsula of Michigan. In Ottawa County, the emergency spillways of two dams in the Rush Creek watershed owned by the Ottawa County Drain Commission were destroyed (Reference 42).

On May 29, 1989, 5 inches of rainfall was recorded over a 24-hour period in the City of Zeeland. Several homes on Rich Avenue along Rose Drain / Tanner Drain were flooded (Reference 42).

Flooding problems along Bliss Creek Intercounty Drain are known to exist at the intersection of Kenowa Avenue and 44th Street, as well as at an older home located approximately a quarter mile north of this intersection on the west side of Kenowa Avenue. Storms on October 17, 1992, and October 17, 1993, caused water to flow over a significant stretch of Kenowa Avenue in the vicinity of this intersection. During these storm events, 3 to 4 inches of rain fell in a 24-hour period. Flooding occurred again at this intersection on May 18, 1996, when 3.5 to 5.5 inches of rain fell. This flood event was estimated to be between a 10- and 2-percent-annual-chance event (Reference 18).

Flooding occurred over the 10-day period from February 24, 1994, to March 5, 1994, when mild temperatures led to a rapid snowmelt. The still-frozen ground prevented the snowmelt from being absorbed and led to a large volume of runoff flowing into the Grand River. On February 24, a 1.5-mile long ice jam on the Grand River in the Township of Robinson caused water levels to rise approximately 5 feet in 45 minutes, resulting water overflowing the river's banks. The river was 5 feet above bankfull by February 25, causing 125 people to be evacuated from 41 homes. By noon on March 5, 1994, when water levels on the Grand River fell below bankfull, 45 homes and 3 businesses had been damaged (Reference 42).

Significant flooding occurred in southwestern Ottawa County on June 18, 1996, as a result of heavy rainfall. Daily rainfall totals of 3.46 inches and 4.41 inches were recorded on June 17 and June 18, respectively. Numerous roads were closed. Near the intersection of US 31 and Lincoln Avenue, the roads were covered by up to 5 feet of water. Homes and businesses were flooded in the areas of Lincoln Avenue and 16th Street in the City of Holland; College Avenue and 19th Street in the City of Holland; and along Pine Creek in the Charter Township of Holland. In the City of Zeeland, Alice Street was flooded between 103rd Avenue and 140th Avenue (Reference 42).

On June 20, 1997, significant rainfall occurred in Ottawa County. Official rainfall totals of 5.47 inches in the City of Holland and 9.16 inches at Holland State Park were recorded. An unofficial reading of 13 inches was recorded in the Zeeland area. Flash flooding occurred along streams in the Charter Townships of Holland, Jamestown, and Zeeland, the Cities of Holland and Zeeland, and the Townships of Chester and Wright. Six bridges and culverts were destroyed. Forty-four roads, including US 31, were impassible during this storm. Of these roads, 40 experienced washouts. Approximately 150 homes and 11 businesses were damaged by the flooding, with most of the damage occurring as a result of flooded basements (Reference 42).

The floodplains in Ottawa County are mostly undeveloped and few structures are found within their extents. However, homes have been built in the 1-percent-annual-chance floodplain in the Township of Robinson along the Grand River. Major flooding from the Grand River in the Township of Robinson has occurred in 1994, 1996, and 1998, while less significant flooding occurs on a nearly annual basis (References 1, 3, 7, and 42).

Peak discharge data from two stream gages within Ottawa County was used for this study. One gage is located on the Grand River upstream of Fulton Street in the City of Grand Rapids (USGS gage no. 04119000). Peak discharge data at this gage has been collected continuously since 1901. The other gage is located on Black Creek of Zeeland Drain at Adams Street in the Charter Township of Holland (USGS gage no. 04108801). Peak discharge data at this gage has been collected continuously since 1961 (Reference 44).

A National Oceanic and Atmospheric Administration (NOAA) gage on Lake Michigan is found in the City of Holland. This gage has been in operation since 1960.

TABLE 6 shows high water marks and peak discharge values from past flooding events as reported by the previously published FISs for communities within Ottawa County and the USGS National Water Information System (NWISWeb). Elevations are in feet in NAVD88 (References 1, 2, 4–6, 8, 10–13, and 44).

TABLE 6 – High Water Marks

Flooding Source & Location	Date	Elevation (ft NAVD88)	Flow (cfs)
Grand River			
Upstream of Fulton Street in Grand Rapids (USGS gage no. 04119000)	Mar. 28, 1904	607.7	54,000
	June 9, 1905	606.8	50,200
	Mar. 20, 1942	603.3	34,000
	Apr. 9, 1947	604.6	38,600
	Mar. 23, 1948	605.2	42,200
	Apr. 3, 1960	604.5	31,800
	Mar. 8, 1976	604.5	28,300
	Mar. 1, 1985	604.9	30,200
	Oct. 4, 1986	604.5	28,300
	May 27, 2004	604.8	29,000

TABLE 6 – High Water Marks *(continued)*

Flooding Source & Location	Date	Elevation (ft NAVD88)	Flow (cfs)
Lake Michigan			
City of Holland	June 17, 1973	582.7	N/A
(NOAA gage no. 7031)	June 22, 1974	582.6	N/A
	Dec. 2, 1985	583.7	N/A
	Oct. 3, 1986	583.1	N/A
Macatawa River / Black Creek of Zeeland Drain			
At Adams Street in the	June 26, 1978	596.96	3,830
Charter Township of Holland	Mar. 4, 1979	596.99	4,180
(USGS gage no. 04108801)	May 11, 1981	598.74	7,220
	July 17, 1982	597.30	4,600
	May 31, 1989	597.22	4,150
	Feb. 20, 1994	597.08	3,800[1]
	May 21, 1996	597.26	4,340
	June 21, 1997	599.65	8,810

1 Discharge is an estimate

2.4 Flood Protection Measures

Bliss Creek Intercounty Drain Diversion Channel was constructed as a bypass on Bliss Creek Intercounty Creek in the Charter Township of Georgetown. This bypass includes a weir structure and an emergency overflow channel (Reference 18).

High water levels on Lake Michigan in the early 1970s prompted some residents and businesses to construct seawalls to protect their individual properties. These measures help to prevent the erosion of beaches (References 4–6, 8, 10–12, and 14).

Several industrial and commercial businesses along the Grand River and Spring Lake have used fill to elevate their construction above the floodplain (References 4, 5, and 13).

Temporary dikes were constructed along the shore of Smith Bayou by the USACE as part of Operation Foresight. These dikes were not considered in the analysis because of their temporary nature (References 4 and 14).

In the summer of 1999, the City of Holland installed several new storm drain pipes and constructed a relief drain that empties into Lake Macatawa off 12th Street as part of a roadway reconstruction project. These measures were intended to eliminate much of the flooding experienced by the city's downtown residential neighborhoods (Reference 19).

In the Township of Robinson, several homes in the Limberlost and VanLopik subdivisions along the Grand River have been elevated to reduce their potential for flooding. In the fall of 1999, township officials agreed to participate with MDEQ and the Michigan State Police Emergency Management Division (MSP-EMD) to secure FEMA Hazard Mitigation Grant Program funding to purchase several repetitive flood loss properties in the area. MSP-EMD also assisted the Maplewood Intercounty Drain Board and the City of Holland to obtain funding from FEMA to purchase two flood-prone homes located on Lincoln Avenue along the Maplewood Intercounty Drain (Reference 42).

The Ottawa County Drain Commission has undertaken projects to reduce the threat of flooding. Improvements have been made along Bliss Creek in the Charter Township of Georgetown to alleviate flooding near the intersection of 44th Street and Kenowa Avenue. A relief drain has been constructed at the Rose Drain in the City of Zeeland. A flood control berm near Pine Creek has been constructed in the Charter Township of Holland to protect a home from flooding. New culverts have been installed under US 31, New Holland Street, Quincy Street, and Riley Street. Improvements have also been made to Berens Dam, Steenwyk Dam, and Timmer Dam in the Black Creek watershed (Reference 42).

There are six publicly-owned dams that fall under the jurisdiction of the Ottawa County Drain Commission. These are Berens Dam in the Township of Blendon, Rush Creek Phase I Dam in the Charter Township of Georgetown, Rush Creek Phase II Dam in the Charter Township of Jamestown, Rush Creek Phase III Dam in the Charter Township of Jamestown, Steenwyk Dam in the Charter Township of Zeeland, and Timmer Dam in the Charter Township of Zeeland. These dams serve to control stormwater during heavy rainfall, improve water quality by entrapping sediment and provide a habitat for wildlife (Reference 42).

Berens Dam, which is also known as Black Creek Watershed Structure 1A, is located on Beaver Dam Drain, a tributary to Black Creek of Zeeland Drain, upstream of New Holland Street. This structure is an earthen dam measuring approximately 31 feet tall at its crest. It was built in 1993 by the Ottawa County Drain Commission as a stormwater detention basin dam. Its storage capacity is 640 acre-feet and does not hold a permanent body of water. This is the only dam in Ottawa County classified as a “significant” hazard under the provisions of Part 315 of the Natural Resources and Environmental Protection Act, 1994 PA 451 (Reference 42).

Rush Creek Phase I Dam, which is also known as Georgetown Dam or Rush Creek Dam, is located at the upper end of Northwest Branch of Rush Creek in the Charter Township of Georgetown. This structure is an earthen dam constructed in 1978 measuring approximately 700 feet long and 17.9 feet tall at its crest. An area measuring 634.6 acres drains to this dam. A 54-inch diameter corrugated metal pipe (CMP) is located at the flow line of the channel and acts at the primary spillway. During periods of increased runoff, outflow through this orifice is regulated by an aluminum slide gate controlled by a motor-operated gearbox above the inlet. A 24-inch diameter CMP located 13 feet above the channel acts as a secondary spillway. An auxiliary spillway, in the form of an overflow weir, is located 14.6 feet above the channel. The dam was originally designed for the 2-percent-annual-chance flood event, but has since been modified to contain the 1-percent-annual-chance flood event (Reference 25).

Rush Creek Phase II Dam, which is also known as DeWeerd Dam or Jamestown Dam, is located on DeWeerd Drain upstream of Interstate 196. This structure is an earthen dam constructed in 1982 measuring approximately 315 feet long and 18.3 feet tall at its crest. An area measuring approximately 700 acres drains to this dam. A 36-inch CMP acts as the primary spillway. During periods of increased runoff, outflow through this orifice is regulated by an aluminum slide gate controlled by a motor-operated gearbox above the inlet. At the eastern side of the earthen berm is a 59 foot long concrete weir for high flow. A poured concrete discharge channel is located on the downstream face of the berm at the weir (Reference 22).

Rush Creek Phase III Dam, which is also known as Buttermilk Dam, is located on Buttermilk Creek upstream on Interstate 196. This structure is an earthen dam with a 60-inch CMP acting as the primary spillway. At the eastern side of the earthen berm is a concrete weir for high flow (Reference 21).

Steenwyn Dam, which is also known as Black Creek Watershed Structure 8, is located upstream of 56th Avenue on an unnamed tributary to Black Creek of Zeeland Drain. This structure is an earthen dam measuring approximately 200 feet long and approximately 28 feet tall at its crest. Its storage capacity is 65 acre-feet. Normal storage is 34 acre-feet (Reference 42).

Timmer Dam is located upstream of Quincy Street between 48th and 56th Avenues on an unnamed tributary to Black Creek of Zeeland Drain. This structure is an earthen dam measuring approximately 25 feet tall at its crest. The dam creates an 11-acre impoundment known as Timmer Dam Pond (Reference 42). In spring 2007, improvements were made to the dam to replace the riser, widen the emergency spillway to 5 feet, and raise the top of the crest of the dam by 1 to 3 feet (Reference 45).

Numerous privately-owned dams are found throughout Ottawa County. Many of these privately-owned dams are located in the Charter Township of Zeeland where soil types and ravines allow for easy construction of earthen dams (Reference 42).

Motman Dam, which is privately-owned, has been noted to be a concern for Ottawa County officials. This structure is an earthen dam located on an unnamed tributary to the Grand River in the Charter Township of Tallmadge. While this dam has not failed, tree roots growing through the dam have created leaks. If the structure were to fail, traffic on M-45 could be disrupted and nearby homes could be flooded (Reference 42).

Ottagon Dam, located in Allegan County just south of Ottagon Street near Old Orchard Avenue in the City of Holland, has the potential to cause flooding in Ottawa County. This dam was built to combat flooding problems in the neighborhood near Ottogan Street. Failure of this dam would result in flooding that could affect the residential area stretching from Ottogan Street north to Lake Macatawa (Reference 42).

3.0 ENGINEERING METHODS

For the flooding sources studied by detailed methods in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude that are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10-, 2-, 1-, and 0.2-percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long-term, average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than one year are considered. For example, the risk of having a flood that equals or exceeds the 1-percent-annual-chance flood in any 50-year period is approximately 40 percent (4 in 10); for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish peak discharge-frequency relationships for each flooding source studied by detailed methods affecting the community. The information provided in this section was obtained from the previously published FIS reports for Ottawa County unless indicated otherwise.

The discharge estimates for the streams previously studied by detailed methods were calculated using the Soil Conservation Service (SCS) method (Reference 46), the unit hydrograph-infiltration capacity method (Reference 47), or by performing frequency analyses of gage data using the log-Pearson Type III distribution (Reference 48). For several streams, hydrologic calculations were performed following the SCS method using the SCS TR-20 computer program (Reference 49) or the HEC-1 Flood Hydrograph Package computer program (Reference 50).

The SCS method, presented in the *National Engineering Handbook* (Reference 46), uses runoff curve numbers and total rainfall depth to model runoff. The runoff curve numbers are determined based on soil characteristics, land use, and the initial abstraction. The initial abstraction consists of interception, depression storage, and infiltration.

The unit hydrograph-infiltration capacity method outlined in *Rainfall-Runoff Relations on Urban and Rural Areas* (Reference 47) was developed to estimate peak discharges on small drainage basins in various stages of urbanization. This method applies unit hydrographs of various frequencies based upon contributing drainage area and degree of urbanization as measured by population density. This method also factors snowmelt and retention and infiltration capacities when forming the runoff hydrograph.

The SCS TR-20 computer program (Reference 49) is used for generating and routing runoff hydrographs following the procedures of the SCS method. Input parameters for TR-20 include total rainfall amounts associated with each flood frequency and individual subbasin characteristics such as runoff curve number, time of concentration, contributing drainage area, reach length, and structure/cross section rating curves.

The HEC-1 computer program (Reference 50) simulates the precipitation-runoff process and can be used to route flow from multiple subbasins to produce hydrographs for watersheds. For streams studied using the HEC-1 computer program, the SCS method was applied using the Type I, 24-hour rainfall distribution presented in the National Weather Service (NWS) Technical Paper (TP-40) (Reference 51). The 10-, 2-, 1-, and 0.2-percent-annual-chance precipitation values were 3.75, 4.7, 5.1, and 6.0 inches, respectively. Runoff curve numbers were selected based on soil type and land use. Time of concentration values were developed from topographic maps and multiplied by 0.6 to obtain the SCS lag (Reference 1).

Peak discharge estimates for Brower & No. 39 Drain were calculated using the SCS method (Reference 9).

Peak discharge estimates for Comstock Drain were calculated using the HEC-1 computer program. Note that the discharges for Comstock Drain decrease proceeding downstream of Cedar Lake Drive. This is caused by a restrictive culvert under Cedar Lake Drive that creates a large storage area just upstream of the crossing (Reference 2).

Peak discharge estimates for Deer Creek were calculated using the SCS method (Reference 3).

Peak discharge estimates for the Grand River were estimated by performing log-Pearson Type III analyses following the procedures of Bulletin No. 17 (Reference 48). These analyses used peak annual discharge data from a gage located in Grand Rapids upstream of Fulton Street (USGS gage no. 04119000). The discharges calculated by performing these frequency analyses were adjusted from the USGS gage site to other locations on the Grand River using drainage area ratio methods. Discharge estimates at the mouth at Lake Michigan are based on 74 years of gage data. Discharge estimates upstream of Lake Michigan Drive used 77 years of gage data (References 1, 4, 5, 13, and 14).

Peak discharge estimates for Hager Drain were calculated using the HEC-1 computer program (Reference 2).

Peak discharge estimates for Harlem Ext. Drain / Harlem Drain were calculated using the TR-20 computer program (References 9 and 10).

Peak discharge estimates for Hunters Creek were calculated using the SCS method (Reference 9).

Peak discharge estimates for Noordeloos Creek were calculated using the SCS method (Reference 9).

Peak discharge estimates for Ottawa Creek & Ext. Drain / Ottawa Drain / Curry Drain were calculated using both the SCS method and the unit hydrograph-infiltration capacity method. The discharges calculated using these two methods were averaged to obtain the final discharges (Reference 1).

South Channel, located in the City of Grand Haven, was studied as a part of the Grand River. No discharges were calculated for this reach (Reference 5).

Peak discharge estimates for Tulip Intercounty Drain were calculated using the SCS method (Reference 9).

Peak discharge estimates for Watson Drain were calculated using the SCS method (Reference 3).

The discharge estimates for new and revised studies were calculated using the MDEQ SCS method (Reference 52), the NRCS Technical Release 55 (TR-55) computer program (Reference 53), the HEC-HMS computer program (Reference 54), the HEC-RAS computer program (Reference 55), the Flood Flow Frequency Analysis computer program 723-X6-L7550 (Reference 56), or a combination of these methods.

The procedure for estimating discharges using the MDEQ SCS method, outlined in MDEQ's *Computing Flood Discharges for Small Ungaged Watersheds* (Reference 52), is similar to the SCS method presented the "Section 4: Hydrology" of the *National Engineering Handbook* (Reference 46). An Excel spreadsheet was produced by MDEQ and has been made publicly available to aid in performing these calculations. Inputs include the rainfall depths associated with each design storm, as obtained from "Bulletin 71" (Reference 57), runoff curve numbers obtained using land use and soil characteristics, times of concentration, and contributing drainage areas.

The TR-55 computer program was used to estimate discharges for subwatersheds with a time of concentration of less than one hour. Discharges in TR-55 are calculated following the procedures described in *WinTR-55 User Manual* (Reference 53) and use the SCS runoff equation to estimate peak discharges. The required inputs for this program are the rainfall depths associated with each design storm, runoff curve numbers, times of concentration, and contributing drainage areas. For this study, these parameters were determined using the MDEQ SCS spreadsheet.

The HEC-HMS computer program was used for flood flow routing. The required inputs for this program are design storm rainfall depths, runoff curve numbers, times of concentration, and contributing drainage areas. For this study, these parameters were determined using the MDEQ SCS spreadsheet.

The HEC-RAS computer program was designed to perform hydraulic analyses for open channels. It was used here for flood flow routing and to perform split flow analyses.

The Flood Flow Frequency Analysis computer program was used to perform frequency analyses. This computer program combines Weibull plotting positions and the log-Pearson Type III distribution to calculate discharge-frequency relationships.

Information on which of the above methods were used for the hydrologic analyses for the newly studied or restudied by detailed methods is discussed below.

Discharge estimates for Alward Drain were calculated using the MDEQ SCS method (Reference 20).

Discharge estimates for Bareman Drain were calculated using the MDEQ SCS method (Reference 58).

Bliss Creek Intercounty Drain and Knight Intercounty Drain were previously studied as part of the Charter Township of Georgetown FIS published in February 1992 (Reference 2). A HEC-HMS model from this previously published FIS was obtained and was updated with current design rainfall depths, runoff curve numbers, times of concentration, and contributing drainage areas. After analyzing the results of the revised HEC-HMS model, it was determined that the previously published 1-percent-annual-chance discharge estimated for Bliss Creek Intercounty Drain upstream of its confluence with Rush Creek was still applicable. The revised HEC-HMS model was used to estimate the 1-percent-annual-chance discharge for Knight Intercounty Drain at Jackson Street. Due to difficulty in calibrating the HEC-HMS model to match the previously published discharges for the remaining design flood events, MDEQ concluded that the previously published discharges for Bliss Creek Intercounty Drain upstream of its confluence with Rush Creek should be used for all the design flood events. The discharge estimates for the 10-, 2-, and 0.2-percent-annual-chance flood events for Knight Intercounty Drain at Jackson Street were estimated using a logarithmic graphical interpretation. Between the confluence of Bliss Creek Intercounty Drain with Rush Creek and Knight Intercounty Drain at Jackson Street, drainage area ratio techniques were used to provide discharge estimates (Reference 24).

Peak discharges at the divergence of Bliss Creek Intercounty Drain and Bliss Creek Intercounty Drain Diversion Channel were calculated using the split flow optimization tool in HEC-RAS. This tool performs iterations of split flows until the energy grade lines of the two reaches are equal. Downstream of the divergence, flow may leave the watershed in the east overbank in the oxbow portion of Bliss Creek Intercounty Drain during periods of high flow. This was modeled in HEC-RAS using a lateral weir. The amount of flow leaving the watershed over the lateral weir was calculated by performing iterations manually until the energy grade lines were equal (Reference 18).

Peak discharge estimates for subbasins along Buttermilk Creek, Unnamed Tributary 1 to Buttermilk Creek, and Unnamed Tributary 2 to Buttermilk Creek were calculated using the MDEQ SCS method and the TR-55 computer program. Only the peak 1-percent-annual-chance discharges were calculated using these methods, so a HEC-HMS model was built to produce hydrographs for each design storm. The 1-percent-annual-chance hydrographs in this HEC-HMS model were calibrated to match the peak discharges calculated using the MDEQ SCS method and the TR-55 computer program. An unsteady-state HEC-RAS model was constructed to allow routing of the subbasin hydrographs so that timing and attenuation effects of the Rush Creek Phase III Dam and the tributaries could be accurately modeled. The final peak discharges for Buttermilk Creek, Unnamed Tributary 1 to Buttermilk Creek, and Unnamed Tributary 2 to Buttermilk Creek were determined once this unsteady-state analysis was completed (Reference 21).

Discharge estimates for County Drain No. 8 and North Holland Drain were calculated using the MDEQ SCS method (Reference 58).

Discharge estimates for County Drain No. 15 & 17 were calculated using the MDEQ SCS method. A portion of the flow along the upstream portion of this stream will be diverted to Vans Bypass via a 36-inch plastic storm sewer. Just upstream of this divergence, discharge estimates for the design floods were calculated using the MDEQ SCS method. The apportionment of discharge between the two streams was calculated using the HEC-RAS computer program and manually performing iterations until the energy grade lines were equal at the divergence (Reference 27).

Discharge estimates for County Drain No. 28 were calculated using the MDEQ SCS method (Reference 58).

Discharge estimates for County Drain No. 40 were calculated using the HEC-HMS computer program (Reference 58).

To estimate peak discharges for DeWeerd Drain, a HEC-HMS model was built to route the flow through Rush Creek Phase II Dam. This model allowed the timing and attenuation effects of the dam to be accurately modeled. Inflow hydrographs at several locations along DeWeerd Drain were developed based on peak discharges calculated using the MDEQ SCS method. The input parameters used to calculate discharges using the MDEQ SCS method were then used to build subbasins in the HEC-HMS model. These subbasins in the HEC-HMS model were then calibrated to produce the same peak discharges as calculated using the MDEQ SCS method by adjusting the storage coefficients. Rush Creek Phase II Dam was built in the HEC-HMS model using field survey data and data obtained from the dam's construction plans. A tailwater rating curve for the dam was developed using the FlowMaster computer program (Reference 59). Cross sections were built using field survey data collected by Spicer Group. Using engineering judgment, the discharges calculated at the outlet of the Rush Creek Phase II Dam with HEC-HMS and discharges calculated at the downstream end of DeWeerd Drain using the MDEQ SCS method were area weighted to produce intermediate discharges along the stream (Reference 22).

Peak discharge estimates for the restudied portion of the Grand River were calculated using peak annual discharge data obtained from a USGS gage located on the Grand River at Grand Rapids, Michigan. The period of record for this data was from 1901 to 2000. A frequency analysis was performed using the Flood Flow Frequency Analysis computer program. A generalized skew of 0.081 was used. The discharges calculated performing this frequency analysis were then adjusted from the USGS gage site to other locations on the Grand River using a drainage area ratio method (Reference 16).

Huizenga Intercounty Drain was previously studied by Fishbeck, Thompson, Carr & Huber, Inc., (FTC&H) and Sandel, Chappell & Shultz, P.C., as part of a watershed management plan published in 1995 (Reference 60). The hydrologic analysis performed as a part of the previously published study was completed using HEC-1. A revised model was completed in 2005 by FTC&H using the HEC-HMS computer program. Runoff curve numbers and contributing drainage areas were updated to reflect changes that have occurred in the watershed since 1995. In building the HEC-HMS model, it was assumed that all detention basins constructed since 1995 have the capacity for a 4-percent-annual-chance flood event. Based on this assumption, the HEC-HMS model was calibrated so that peak discharge estimates produced for the 4-percent-annual-chance flood event match those of the 1995 HEC-1 model. Calibration to the 4-percent-annual-chance flood was done by adjusting the subbasin times of concentration to produce peak discharges matching existing conditions in 1995. Peak discharges were routed through the Kenowa Lake Level Control Structure using level-pool routing techniques in HEC-HMS. An elevation-storage curve for the Kenowa Lake impoundment was calculated based on survey, contour, and hydrographic data. A range of discharges were input into the HEC-HMS model to develop a comprehensive elevation-discharge rating curve. The storage-discharge rating curve was created by interpolating the storage from the elevation-storage curve for a given discharge and elevation (References 19 and 23).

Peak discharge estimates for the Macatawa River / Black Creek of Zeeland Drain were calculated using peak annual discharge data obtained from a USGS gage located on Black Creek of Zeeland Drain near Zeeland, Michigan. The period of record was from 1961 to 2000. A frequency analysis was performed using the Flood Flow Frequency Analysis computer program. A generalized skew of 0.081 was used. The discharges calculated performing this frequency analysis were then adjusted from the USGS gage site to other locations on the Macatawa River / Black Creek of Zeeland Drain using a drainage area ratio method (Reference 17).

Peak discharge estimates for Meadowbrook Drain were calculated using the MDEQ SCS method (Reference 24).

Peak discharge estimates for two subbasins along Northwest Branch of Rush Creek were calculated using the MDEQ SCS method. To account for the timing and attenuation effects of Rush Creek Phase I Dam, a HEC-HMS model was built. The input parameters used to calculate peak discharges using the MDEQ SCS method were then used to build subbasins in the HEC-HMS model. These subbasins in the HEC-HMS model were calibrated to produce the same peak discharges as calculated using the MDEQ SCS method by adjusting the storage coefficients. Rush Creek Phase I Dam was built in the HEC-HMS model using field survey data and data obtained from the dam's construction plans. A tailwater rating curve for the dam was developed using the FlowMaster computer program (Reference 59). Cross sections were built using field survey data collected by Spicer Group (Reference 25).

Peak discharge estimates for subbasins along Rush Creek were calculated using the MDEQ SCS method and the TR-55 computer program. Due to the existence of dams, lakes, and substantial floodplain storage, an unsteady-state HEC-RAS model was constructed. This unsteady-state model allowed routing of the subbasin hydrographs so that timing and attenuation effects could be accurately modeled. The final peak discharges for Rush Creek were determined once the unsteady-state analysis was completed (Reference 26).

Peak discharge estimates for Trout Drain were calculated using the MDEQ SCS method and the TR-55 computer program (Reference 27).

Peak discharge estimates for Windmill Creek were calculated using the HEC-HMS computer program (Reference 58).

Peak discharge-drainage area relationships for the 10-, 2-, 1-, and 0.2-percent-annual-chance flood events of the flooding sources studied in detail are shown in TABLE 7 (References 1, 3–5, 7, 9, 13, 14, 16, 17, 19–27, and 58).

TABLE 7 – Peak Discharge Values

		Peak Discharges (cfs)			
Flooding Source and Location	Drainage Area (Sq. Miles)	10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Alward Drain					
Upstream of confluence with Rush Creek	1.41	140[1]	290[1]	400[1]	700[1]
At 36th Avenue	1.35	140	290	400	700
Bareman Drain					
Upstream of confluence with County Drain No. 15 & 17	1.27	120	220	280[1]	480[1]
Just downstream of confluence with Vans Bypass	1.24	120	220	280	480
At Riley Street	1.18	90[1]	200[1]	270[1]	470[1]
At Beeline Road	0.91	90	200	270	470
At Quincy Street	0.27	60	120	150	260

1 Higher discharge from an upstream design point is used

TABLE 7 – Peak Discharge Values *(continued)*

Flooding Source and Location	Drainage Area (Sq. Miles)	Peak Discharges (cfs) 10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Bliss Creek Drain Intercounty Drain					
Upstream of confluence with Rush Creek	28.6	1,298.57[1]	1,954.05[1]	2,165.75[1]	2,809.33[1]
Just downstream of confluence with Meadowbrook Drain	28.3	1,298.57	1,954.05	2,165.75	2,809.33
Just downstream of confluence with Bliss Creek Intercounty Drain Diversion Channel	27.1	1,218.57	1,834.05	2,025.75	2,629.33
At a point approximately 1,075 feet upstream of confluence with Bliss Creek Intercounty Drain Diversion Channel	27.0[2]	162.73	252.88	271.29	345.97
Just downstream of divergence with Bliss Creek Intercounty Drain Diversion Channel	27.0[2]	204.16	373.83	545.54	751.64
Just upstream of divergence with Bliss Creek Intercounty Drain Diversion Channel	27.0	1,260	1,955	2,300	3,035
At a point approximately 15 feet upstream of divergence with Bliss Creek Intercounty Drain Diversion Channel	27.0[2]	1,100	1,800	2,100	2,900
At confluence with unnamed tributary, NE 1/4 of Section 36 of T6N.R13W	26.4	1,000	1,800	2,100	2,800
Just downstream of confluence with Knight Intercounty Drain	25.4	950	1,700	2,000	2,700
Bliss Creek Intercounty Drain Diversion Channel					
Just downstream of divergence from Bliss Creek Intercounty Drain	27.0[2]	1,055.84	1,581.17	1,754.46	2,283.36
Brower & No. 39 Drain					
Upstream of confluence with Hunters Creek	3.90	320	520	600	775

1 Higher discharge from an upstream design point is used
2 Drainage area is approximate

TABLE 7 – Peak Discharge Values *(continued)*

Flooding Source and Location	Drainage Area (Sq. Miles)	Peak Discharges (cfs) 10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Buttermilk Creek					
Upstream of confluence with Rush Creek	3.84	550	900	1,100	2,000
Upstream of Chicago Drive	3.62	550	950	1,100	2,000
At sheet pile weir, SE 1/4 of Section 32 of T6N.R13W	3.30	500	850	1,100	1,900
Just downstream of confluence with Unnamed Tributary 1 to Buttermilk Creek	2.77	460	700	900	1,900
Just downstream of Rush Creek Phase III Dam	1.57	160	190	210	1,700
Just downstream of confluence with Unnamed Tributary 2 to Buttermilk Creek	1.56	180	250	270	1,800
At Quincy Street	0.40	150	280	340	480
Comstock Drain					
Upstream of confluence with Grand River	3.80	220	240	255	280
Just downstream of Fillmore Street	3.50	205	215	220	230
Just upstream of Fillmore Street	3.50	230	300	325	370
Just downstream of Cedar Lake Drive	3.40	225	295	315	360
Just upstream of Cedar Lake Drive	3.40	460	695	800	1,055
At 24th Avenue	2.90	390	600	690	915
Upstream of confluence with Hager Creek	0.95	170	260	300	395
County Drain No. 8 and North Holland Drain					
Upstream of confluence with County Drain No. 15 & 17 and County Drain No. 40	2.22	70[1]	170[1]	230[1]	410[1]
At Riley Street	1.77	70	170	230	410
At Quincy Street	1.23	70	160	220	390

[1] Higher discharge from an upstream design point is used

TABLE 7 – Peak Discharge Values *(continued)*

Flooding Source and Location	Drainage Area (Sq. Miles)	Peak Discharges (cfs) 10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
County Drain No. 15 & 17					
Upstream of confluence with County Drain No. 8 and North Holland Drain and County Drain No. 40	4.00	210[1]	460[1]	600[1]	1,100[1]
Just downstream of confluence with Bareman Drain	3.89	210	460	600	1,100
At Riley Street	2.57[3]	188.2[1]	394[1]	527[1]	880[1]
Downstream of divergence with Vans Bypass	*	188.2	394	527	880
Upstream of divergence with Vans Bypass	2.55	200	420	550	950
County Drain No. 28					
Upstream of confluence with County Drain No. 40 and Windmill Creek	1.79	110	260[1]	340	600
At Horizon Outlet Mall driveway	1.66	110	260	340	600
At James Street	1.35	110	240	320	550
County Drain No. 40					
Upstream of confluence with County Drain No. 28 and Windmill Creek	7.55	330[1]	700[1]	900[1]	1,300[1]
At US 31	7.52	330	700	900	1,300
At Lakewood Boulevard	6.98	300	650	825	1,200
Just downstream of confluence with County Drain No. 8 and North Holland Drain and County Drain No. 15 & 17	6.21	270	600	750	1,100
Deer Creek					
At Interstate 96 Westbound	20.5	1,200	1,800	2,000	2,700
At a point approximately 1,700 feet downstream of Cleveland Street	18.7	1,080	1,550	1,780	2,300

* Data not available

1 Higher discharge from an upstream design point is used

3 This includes the contributing drainage area of County Drain No. 15 & 17 just upstream of the divergence of Vans Bypass as well the area contributing to County Drain No. 15 & 17 downstream of the divergence.

TABLE 7 – Peak Discharge Values *(continued)*

Flooding Source and Location	Drainage Area (Sq. Miles)	Peak Discharges (cfs) 10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
DeWeerd Drain					
Upstream of confluence with Rush Creek	5.66	430	850	1,100	1,600
Just downstream of confluence with Jo Drain	2.91	320	650	800	1,150
Just downstream of confluence with Trout Drain	2.08	240	470	600	850
At Van Buren Street	1.96	200	400	500	700
At New Holland Street	1.33	110	140	150	410
Just downstream of Rush Creek Phase II Dam (Dam No. 00812)	1.12	110	140	150	410
Just upstream of Rush Creek Phase II Dam (Dam No. 00812)	1.12	230	430	550	750
Grand River					
At mouth at Lake Michigan	5,572	36,500	53,000	61,000	82,000
Downstream of the confluence with Crockery Creek	*	*	*	60,000	81,000
Downstream of the confluence with Bass River	*	*	*	59,000	80,000
At M-45	*	*	*	58,000	78,000
At Lake Michigan Drive	5,190	34,700	50,500	57,900	77,900
Upstream of the Charter Township of Allendale / Charter Township of Georgetown corporate limits	5,165	34,700	50,520	57,920	77,950
At a point approximately 2.5 miles downstream of the Ottawa / Kent County boundary	5,100	34,200	49,800	57,000	76,700
At the Ottawa / Kent County boundary	4,980	33,500	48,700	55,800	75,100
Upstream of Fulton Street in the City of Grand Rapids (USGS gage no. 04119000)	4,900	33,000	48,000	55,000	74,000
Hager Creek					
Upstream of confluence with Comstock Drain	0.45	70	100	115	145
Harlem Ext. Drain / Harlem Drain					
At 144th Avenue	10.8	320	510	590	740

* Data not available

TABLE 7 – Peak Discharge Values *(continued)*

Flooding Source and Location	Drainage Area (Sq. Miles)	Peak Discharges (cfs) 10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Huizenga Intercounty Drain					
Upstream of confluence with Rush Creek	3.93	310	650	950	1,900
Downstream of Kenowa Lake Control Structure	3.55	300[4]	650[4]	900[4]	1,800[4]
Upstream of Kenowa Lake Control Structure	3.54	440[4]	950[4]	1,200[4]	2,000[4]
At Kenowa Avenue	3.39	410	850	1,100	1,900
Hunters Creek					
Upstream of confluence with Noordeloos Creek	7.20	695	1,100	1,270	1,610
Upstream of confluence with Brower & No. 39 Drain	3.10	375	580	670	840
Knight Intercounty Drain					
Upstream of confluence with Bliss Creek Intercounty Drain	10.4	430	750	900	1,200
At confluence with unnamed tributary, NW 1/4 of Section 6 of T5N.R12W	10.0	410	750	850	1,200
Macatawa River / Black Creek of Zeeland Drain					
At mouth at Lake Macatawa	134	9,200	12,000	17,000	24,000
At US 31	126	8,800	11,000	16,000	23,000
At Paw Paw Drive	87.0	6,300	7,800	12,000	17,000
At Adams Street (USGS gage no. 04108801)	65.8	4,900	6,100	9,200	13,000
Meadowbrook Drain					
Upstream of confluence with Bliss Creek Intercounty Drain	0.92	170[1]	320[1]	400[1]	650[1]
At confluence with unnamed tributary, SW 1/4 of Section 24 of T6N.R13W	0.82	170[1]	320[1]	400[1]	650[1]
At confluence with unnamed tributary, NW 1/4 of Section 24 of T6N.R13W	0.46	170	320	400	650
Noordeloos Creek					
Upstream of confluence with Black Creek of Zeeland Drain	26.3	1,470	2,320	2,680	3,400
Downstream of confluence with County Drain No. 20	20.0	1,100	1,740	2,025	2,570
Upstream of confluence with County Drain No. 20	12.8	445	700	815	1,030

1 Higher discharge from an upstream design point is used

4 Discharge taken from HEC-HMS model to show attenuation through Kenowa Lake Dam

TABLE 7 – Peak Discharge Values *(continued)*

Flooding Source and Location	Drainage Area (Sq. Miles)	Peak Discharges (cfs) 10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Northwest Branch of Rush Creek					
Upstream of confluence with Rush Creek	5.94	140	240	340	700
Just downstream of Rush Creek Phase I Dam (Dam No. 00704)	5.68	140	240	340	700
Just upstream of Rush Creek Phase I Dam (Dam No. 00704)	5.68	210	550	750	1,400
Ottawa Creek & Ext. Drain / Ottawa Drain / Curry Drain					
Upstream of confluence with Grand River	3.92	425	605	685	890
Rush Creek					
At the Kent / Ottawa County boundary	59.7	2,198	3,938	4,580	5,478
Just downstream of confluence with Huizenga Intercounty Drain	59.6[2]	2,198	3,938	4,580	5,478
Just upstream of confluence with Huizenga Intercounty Drain	55.7	2,100	3,772	4,580	5,303
Just downstream of confluence with Bliss Creek Intercounty Drain	55.3	2,098	3,755	4,355	5,295
At a point approximately 1,530 feet upstream of 12th Avenue	30.0[2]	881	2,185	2,751	3,976
At a point approximately 2,800 feet upstream of 12th Avenue	24.7	800	2,024	2,506	3,442
At a point approximately 1,370 feet downstream of railroad crossing	18.0[2]	782	2,017	2,412	3,000
At a point approximately 520 feet upstream of railroad crossing	16.2	643	1,523	1,761	2,606
At a point approximately 1,300 feet downstream of confluence with Buttermilk Creek	15.0[2]	643	1,523	1,761	2,606
Just downstream of confluence with Buttermilk Creek	14.1	567	1,203	1,437	2,331
Just upstream of confluence with Buttermilk Creek	10.5	356	737	998	1,960
Just downstream of confluence with Alward Drain	10.0[2]	305	705	829	1,481
At 40th Avenue	8.19	283	592	738	1,151

2 Drainage area is approximate

TABLE 7 – Peak Discharge Values *(continued)*

Flooding Source and Location	Drainage Area (Sq. Miles)	Peak Discharges (cfs) 10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Trout Drain					
Upstream of confluence with Black Creek of Zeeland Drain	0.46	50	110	150	250
At a point approximately 100 feet downstream of Edson Drive	0.41[2]	45	105	140	235
At Van Buren Street	0.34	45	100	130	220
At private drive	0.23[2]	30	70	90	140
At a point approximately 530 feet downstream of 22nd Avenue	0.01	15	30	35	50
Tulip Intercounty Drain					
Upstream of confluence with Macatawa River	*	1,550	4,450	5,480	7,600
At a point approximately 400 feet upstream of Adams Street	18.5	565	890	1,025	1,400
Unnamed Tributary 1 to Buttermilk Creek					
Upstream of confluence with Buttermilk Creek	0.79	230	350	550	700
At Interstate 96	0.56	180	330	400	550
Unnamed Tributary 2 to Buttermilk Creek					
Upstream of confluence with Buttermilk Creek	0.24	220	430	600	700
At Quincy Street	0.07	70	120	150	220
Vans Bypass					
Upstream of confluence with Bareman Drain	2.58[5]	25	30	30	80
At Riley Street	2.56[5]	11.8	26	23[6]	70
Downstream of divergence with County Drain No. 15 & 17	2.55[5]	11.8	26	23[6]	70
Watson Drain					
Upstream of confluence with Grand River	2.32	137	208	240	305

* Data not available

2 Drainage area is approximate

5 This includes the contributing drainage area of County Drain No. 15 & 17 just upstream of the divergence of Vans Bypass as well the area contributing to County Drain No. 15 & 17 downstream of the divergence.

6 Due to backwater effects from Bareman Drain, the peak discharge for the 1-percent-annual-chance flood event is less than the peak discharge for the 2-percent-annual-chance flood event

TABLE 7 – Peak Discharge Values *(continued)*

Flooding Source and Location	Drainage Area (Sq. Miles)	Peak Discharges (cfs) 10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Windmill Creek					
Upstream of confluence with Macatawa River	9.39	420[1]	900[1]	1,100[1]	1,700[1]
Just downstream of railroad crossing	9.34	420	900	1,100	1,700

1 Higher discharge from an upstream design point is used

Stillwater flood elevations for the flooding sources studied by detailed methods were obtained from previously published FIS reports, the USACE's *Revised Report on Great Lakes Open-Coast Flood Levels* (Reference 40), or a database provided by MDEQ (Reference 39). When available, information regarding the hydrologic analyses performed is provided below. The 1-percent-annual-chance water-surface elevations for Creekside Lake, East Georgetown Shores Lake, Morning Dew Lake, Rushmore Lake, Waterfront Lake, and West Georgetown Shores Lake were obtained from the MDEQ database and no information regarding the hydrologic analyses performed to obtain these elevations was available for this study.

Water-surface elevations for Black Lake were found through an analysis of rainfall records supplied by the U.S. Weather Bureau. The SCS TR-20 computer program was used to perform reservoir routing to estimate the 10-, 2-, 1-, and 0.2-percent-annual-chance levels. Rainfall data was taken from TP-40. Watershed boundaries were determined using topographic maps. Cross sections for the outlet were obtained by field survey in 1976. Because Black Lake lies approximately 15 feet above Lake Michigan, no consideration was given to the backwater effects from open-coast flood levels (Reference 12).

Water-surface elevations for Cedar Lake were modeled using the SCS TR-20 computer program (Reference 2).

No hydrologic analysis was performed for Lake Macatawa. A hydraulic analysis performed on the channel connecting Lake Macatawa and Lake Michigan indicated that all gradual variations in the water-surface elevation of Lake Michigan would be conveyed to Lake Macatawa. This analysis was performed using the HEC-2 step-backwater computer program. Cross sections used for the model were obtained by field survey in 1976 (Reference 10).

In 1974, FEMA contracted the USACE to determine the 1-percent-annual-chance flood levels for the Great Lakes along the U.S. shoreline. The USACE performed frequency analyses on peak-annual water-surface elevations recorded by water level gages using the log-Pearson Type III distribution to estimate the flood levels. The results of this study were published in 1977 in a report entitled *Report on Great Lakes Open-Coast Flood Levels*. In the mid-1980s, the Great Lakes experienced record high water levels, which in some locations equaled or exceeded the levels published in the 1977 report. In 1987, FEMA contracted the USACE to update the 1977 study by incorporating the additional water level data collected from 1975 through 1987. The updated study was published in 1988 in a report entitled *Revised Report on Great Lakes Open-Coast Flood Levels* (Reference 40). Water-surface elevations for Lake Michigan were obtained from this report.

Water-surface elevations for Lloyds Bayou were determined by analyzing the watershed for runoff and for the effects of backwater from the Grand River and Lake Michigan. The analyses indicated that backwater from the Grand River and Lake Michigan had the dominant influence (Reference 12).

It was found that flood levels of the Grand River would control the peak flood elevations of Millhouse Bayou. Therefore, no hydrologic analysis was performed to determine the flows from local drainage areas (Reference 8).

No hydrologic analysis was performed for Pigeon Lake. A hydraulic analysis performed on the channel connecting Pigeon Lake and Lake Michigan indicated that all gradual variations in the water-surface elevation of Lake Michigan would be conveyed to Pigeon Lake. This analysis was performed using the HEC-2 step-backwater computer program. Cross sections used for the model were obtained by field survey in 1976 (Reference 11).

It was found that flood levels of the Grand River would control the peak flood elevations of Pottawattomie Bayou. Therefore, no hydrologic analysis was performed to determine the flows from local drainage areas (Reference 8).

Water-surface elevations for Spring Lake were determined by analyzing the watershed for runoff and for the effects of backwater from the Grand River and Lake Michigan. The analyses indicated that backwater from the Grand River and Lake Michigan had the dominant influence (Reference 12).

The stillwater elevations for the 10-, 2-, 1-, and 0.2-percent-annual-chance flood events for the flooding sources studied in detail are shown in TABLE 8 (References 2, 8, 10–12, 39, and 40).

TABLE 8 – Summary of Stillwater Elevations

	Peak Elevation (feet NAVD88)			
Flooding Source and Location	10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Black Lake				
Township of Spring Lake	599.0	599.9	600.2	600.8
Cedar Lake East				
Charter Township of Georgetown	606.2	607.3	607.6	608.4
Creekside Lake				
Charter Township of Georgetown	*	*	608.8	*
East Georgetown Shores Lake				
Charter Township of Georgetown	*	*	609.4	*

* Data not available

TABLE 8 – Summary of Stillwater Elevations *(continued)*

Flooding Source and Location	Peak Elevation (feet NAVD88) 10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Lake Macatawa				
Charter Township and City of Holland and Township of Park	582.8[1]	583.9[1]	584.3[1]	585.2[1]
Lake Michigan				
Entire shoreline	582.8	583.9	584.3	585.2
Lloyd's Bayou				
Township and Village of Spring Lake	582.8[1]	583.9[1]	584.7[2]	586.6[2]
Morning Dew Lake				
Charter Township of Holland	*	*	610.3	*
Mill House Bayou				
Chater Township of Grand Haven	584.9[2]	586.7[2]	587.5[2]	589.5[2]
Pigeon Lake				
Township of Port Sheldon	582.8[1]	583.9[1]	584.3[1]	585.2[1]
Pottawattomie Bayou				
Charter Township and City of Grand Haven	584.4[2]	586.3[2]	587.1[2]	589.1[2]
Rushmore Lake				
Charter Township of Georgetown	*	*	606.8	*
Spring Lake				
City of Ferrysburg and Township and Village of Spring Lake	582.8[1]	583.9[1]	584.3[1]	585.2[1]
Waterfront Lake				
Charter Township of Georgetown	*	*	606.7	*
West Georgetown Shores Lake				
Charter Township of Georgetown	*	*	608.9	*

* Data not available
1 Elevation controlled by peak flood elevation of Lake Michigan
2 Elevation controlled by peak flood elevation of the Grand River

Hydrologic calculations were performed using approximate methods for each of the approximate-study streams listed in Section 1.2 to estimate the peak 1-percent-annual-chance flood discharges.

Discharges for the approximate-study streams studied as a part of Phase I were provided by MDEQ. No information regarding the hydrologic analyses performed to estimate the discharges for these streams was available for this study.

Discharges for the approximate-study stream studied as a part of Phase II were calculated by Stantec. Subbasins were delineated at various locations along each reach. The method of analysis used for each subbasin was selected based upon the contributing drainage area.

For basins with contributing drainage areas less than 20 square miles, 1-percent-annual-chance discharges were calculated using the MDEQ SCS method, outlined in MDEQ's *Computing Flood Discharges for Small Ungaged Watersheds* (Reference 52).

For basins with contributing drainage areas greater than 20 square miles, 1-percent-annual-chance discharges were calculated using the with National Flood Frequency (NFF) program (Reference 62) to apply the regression equations presented in USGS' "Water-Resources Investigation Report 94-4002" (Reference 63). These regression equations were developed from peak-discharge records available through 1982 from 185 gaging stations with 10 or more years of record. They are applicable to unregulated, rural streams draining less than 1,000 square miles and have standard errors of estimation ranging from 30 to 40 percent.

The stillwater elevations for the 1-percent-annual-chance flood event for the lakes previously studied by approximate methods were obtained from the database provided by MDEQ. No information regarding the hydrologic analyses performed to obtain these elevations was available for this study.

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Revised Countywide FIS

No new hydrologic analyses were performed as part of the May 16, 2013, revision. The peak discharges applied in the PMR hydraulics model were obtained from previously published FIS reports.

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals. Users should be aware that flood elevations shown on the Flood Insurance Rate Map (FIRM) represent rounded whole-foot elevations and may not exactly reflect the elevations shown on the Flood Profiles or in the Floodway Data table in the FIS report. Flood elevations shown on the FIRM are primarily intended for flood insurance rating purposes. For construction and/or floodplain management purposes, users are cautioned to use the flood elevation data presented in this FIS report in conjunction with the data shown on the FIRM.

Cross section data used in the riverine hydraulic models are described in TABLE 9. The methods used to obtain cross section data for each hydraulic study are listed (References 1–10, 12–14, 16–19, and 28–38).

TABLE 9 – Cross Section Data

Flooding Source	Location	Description
Alward Drain	Charter Township of Georgetown	Channel cross sections for backwater analyses were obtained from field surveys completed in May 2005. Overbank cross-sectional data was obtained from a DEM generated from LiDAR mass point data obtained from Ottawa County GIS in October 2004. All bridges and culverts were field surveyed to obtain elevation and structural geometry.
Bareman Drain	Charter Township of Holland	Channel cross sections for backwater analyses were obtained from field surveys completed in May 2005. Overbank cross-sectional data was obtained from a DEM generated from LiDAR mass point data obtained from Ottawa County GIS in October 2004. All bridges and culverts were field surveyed to obtain elevation and structural geometry.
Bliss Creek Intercounty Drain	Charter Township of Georgetown	Channel cross sections for backwater analyses were obtained from field surveys completed in May 2005. Overbank cross-sectional data was obtained from a DEM created using 2-foot contours obtained from Kent County GIS in October 2004 and LiDAR mass point data obtained from Ottawa County GIS in July 2005. All bridges and culverts were field surveyed to obtain elevation and structural data.
Bliss Creek Intercounty Drain Diversion Channel	Charter Township of Georgetown	Channel cross sections for backwater analyses were obtained from field surveys completed in May 2005. Overbank cross-sectional data was obtained from a DEM created using LiDAR mass point data obtained from Ottawa County GIS in July 2005. All bridges and culverts were field surveyed to obtain elevation and structural data.
Brower & No. 39 Drain	Charter Township of Holland	Channel cross sections for backwater analyses were obtained by field survey. Overbank cross-sectional data was obtained from a 1979 aerial topographic map (Reference 67). All bridges and culverts were field surveyed to obtain elevation and structural geometry.

TABLE 9 – Cross Section Data *(continued)*

Flooding Source	Location	Description
Buttermilk Creek	Charter Township of Zeeland and City of Hudsonville	Channel cross sections for backwater analyses were obtained from field surveys completed in March 2005. Overbank cross-sectional data was obtained from a DEM generated from LiDAR mass point data obtained from Ottawa County GIS in October 2004. All bridges and culverts were field surveyed to obtain elevation and structural geometry.
Comstock Drain	Charter Township of Georgetown	Cross sections for backwater analyses were obtained by field survey. All bridges and culverts were field surveyed to obtain elevation and structural geometry.
County Drain No. 8 and North Holland Drain	Charter Township of Holland	Channel cross sections for backwater analyses were obtained from field surveys completed in May 2005. Overbank cross-sectional data was obtained from a DEM generated from LiDAR mass point data obtained from Ottawa County GIS in October 2004. All bridges and culverts were field surveyed to obtain elevation and structural geometry.
County Drain No. 15 & 17	Charter Township of Holland	Channel cross sections for backwater analyses were obtained from field surveys completed in May 2005. Overbank cross-sectional data was obtained from a DEM generated from LiDAR mass point data obtained from Ottawa County GIS in October 2004. All bridges and culverts were field surveyed to obtain elevation and structural geometry.
County Drain No. 28	Charter Township of Holland	Channel cross sections for backwater analyses were obtained from field surveys completed in May 2005. Overbank cross-sectional data was obtained from a DEM generated from LiDAR mass point data obtained from Ottawa County GIS in October 2004. All bridges and culverts were field surveyed to obtain elevation and structural geometry.

TABLE 9 – Cross Section Data *(continued)*

Flooding Source	Location	Description
County Drain No. 40	Charter Township of Holland	Channel cross sections for backwater analyses were obtained from field surveys completed in May 2005. Overbank cross-sectional data was obtained from a DEM generated from LiDAR mass point data obtained from Ottawa County GIS in February 2005. All bridges and culverts were field surveyed to obtain elevation and structural geometry.
Deer Creek	City of Cooperville	Cross sections for backwater analyses were obtained by field surveys in August 1980. All bridges and culverts were field surveyed to obtain elevation and structural geometry.
DeWeerd Drain	Charter Townships of Georgetown and Jamestown and City of Hudsonville	Channel cross sections for backwater analyses were obtained from field surveys completed in March 2005. Overbank cross-sectional data was obtained from a DEM generated from LiDAR mass point data obtained from Ottawa County GIS in October 2004. All bridges and culverts were field surveyed to obtain elevation and structural geometry.
Grand River	Charter Township of Grand Haven, Cities of Ferrysburg and Grand Haven, Township Spring Lake, and Village of Spring Lake	Cross sections for backwater analyses were obtained by field surveys in 1975 and 1976. All bridges and culverts were field surveyed to obtain elevation and structural geometry.
	Charter Townships of Allendale[1], Polkton, and Tallmadge[1] and Townships of Crockery and Robinson	Channel cross sections for backwater analyses were obtained by field surveys. Overbank cross-sectional data was obtained from LiDAR data collected for this study. All bridges and culverts were field surveyed to obtain elevation and structural geometry.

1 Downstream of a point approximately 800 feet downstream of the westbound Lake Michigan Drive bridge

TABLE 9 – Cross Section Data *(continued)*

Flooding Source	Location	Description
Grand River *(continued)*	Charter Townships of Allendale[2], Georgetown[3], and Tallmadge[4]	Channel cross sections for backwater analyses were obtained by field survey in 2008. Overbank cross-sectional data was obtained from 2-foot contours provided by Ottawa County GIS in 2008. Bridge geometry for the Lake Michigan Drive bridges was obtained from construction plans.
	Charter Townships of Allendale[5], Georgetown, and Tallmadge[5]	Channel cross sections for backwater analyses were obtained by field surveys in July 1979. Overbank cross-sectional data data was obtained from a 1976 aerial topographic map (Reference 64).
Hager Creek	Charter Township of Georgetown	Cross sections for backwater analyses were obtained by field surveys. All bridges and culverts were field surveyed to obtain elevation and structural geometry.
Harlem Ext. Drain	Township of Park	Cross sections for backwater analyses were obtained by field surveys in 1976. All bridges and culverts were field surveyed to obtain elevation and structural geometry.
Harlem Drain	Charter Township of Holland	Channel cross sections for backwater analyses were obtained by field survey. Overbank cross-sectional data was obtained from a 1979 aerial topographic map (Reference 67). All bridges and culverts were field surveyed to obtain elevation and structural geometry.
Huizenga Intercounty Drain	Charter Township of Georgetown	Channel cross sections for backwater analyses were obtained from field surveys completed in December 2004. Overbank cross-sectional data was obtained from a DEM created using two-foot contours obtained from Kent County GIS in October 2004 and LiDAR mass point data obtained from Ottawa County GIS in July 2005. All bridges and culverts were field surveyed to obtain elevation and structural data.

2 Upstream of a point approximately 800 feet downstream of the westbound Lake Michigan Drive bridge

3 Downstream of a point approximately 1.8 mile upstream of the eastbound Lake Michigan Drive bridge

4 From a point approximately 800 feet downstream of the westbound Lake Michigan Drive bridge to a point approximately 1.8 miles upstream of the eastbound Lake Michigan Drive bridge

5 Upstream of a point approximately 1.8 miles upstream of the eastbound Lake Michigan Drive bridge

TABLE 9 – Cross Section Data *(continued)*

Flooding Source	Location	Description
Hunters Creek	Charter Township of Holland	Channel cross sections for backwater analyses were obtained by field survey. Overbank cross-sectional data was obtained from a 1979 aerial topographic map (Reference 67). All bridges and culverts were field surveyed to obtain elevation and structural geometry.
Knight Intercounty Drain	Charter Townships of Georgetown and Jamestown	Channel cross sections for backwater analyses were obtained from field surveys completed in May 2005. Overbank cross-sectional data was obtained from a DEM created using two-foot contours obtained from Kent County GIS in October 2004 and LiDAR mass point data obtained from Ottawa County GIS in July 2005. All bridges and culverts were field surveyed to obtain elevation and structural data.
Macatawa River / Black Creek of Zeeland Drain	Charter Townships of Holland and Zeeland and City of Holland	Channel cross sections for backwater analyses were obtained by field surveys. Overbank cross-sectional data was obtained from the 1990 Township of Holland FIS. All bridges and culverts were field surveyed to obtain elevation and structural geometry.
Meadowbrook Drain	Charter Township of Georgetown	Channel cross sections for backwater analyses were obtained from field surveys completed in May 2005. Overbank cross-sectional data was obtained from a DEM created using LiDAR mass point data obtained from Ottawa County GIS in July 2005. All bridges and culverts were field surveyed to obtain elevation and structural data.
Noordeloos Creek	Charter Township of Holland	Channel cross sections for backwater analyses were obtained by field survey. Overbank cross-sectional data was obtained from a 1979 aerial topographic map (Reference 67). All bridges and culverts were field surveyed to obtain elevation and structural geometry.

TABLE 9 – Cross Section Data *(continued)*

Flooding Source	Location	Description
Northwest Branch of Rush Creek	Charter Township of Georgetown	Channel cross sections for backwater analyses were obtained from field surveys completed in April 2005. Overbank cross-sectional data was obtained from a DEM generated from LiDAR mass point data obtained from Ottawa County GIS in October 2004. All bridges and culverts were field surveyed to obtain elevation and structural geometry.
Ottawa Creek & Ext. Drain / Ottawa Drain / Curry Drain	Charter Township of Allendale	Cross sections for backwater analyses were obtained by field survey in July 1979. All bridges and culverts were field surveyed to obtain elevation and structural geometry.
Rush Creek	Charter Township of Georgetown and City of Hudsonville	Channel cross sections for backwater analyses were obtained from field surveys completed in March 2005. Overbank cross-sectional data was obtained from a DEM generated from LiDAR mass point data obtained from Ottawa County GIS in October 2004. All bridges and culverts were field surveyed to obtain elevation and structural geometry.
South Channel	City of Grand Haven	Cross sections for backwater analyses were obtained by field survey in 1975 and 1976. All bridges and culverts were field surveyed to obtain elevation and structural geometry.
Trout Drain	Charter Township of Georgetown and City of Hudsonville	Channel cross sections for backwater analyses were obtained from field surveys completed in May 2005. Overbank cross-sectional data was obtained from a DEM generated from LiDAR mass point data obtained from Ottawa County GIS in October 2004. All bridges and culverts were field surveyed to obtain elevation and structural geometry.
Tulip Intercounty Drain	Charter Township of Holland	Channel cross sections for backwater analyses were obtained by field survey. Overbank cross-sectional data was obtained from a 1979 aerial topographic map (Reference 67). All bridges and culverts were field surveyed to obtain elevation and structural geometry.

TABLE 9 – Cross Section Data *(continued)*

Flooding Source	Location	Description
Unnamed Tributary 1 to Buttermilk Creek	City of Hudsonville	Channel cross sections for backwater analyses were obtained from field surveys completed in March 2005. Overbank cross-sectional data was obtained from a DEM generated from LiDAR mass point data obtained from Ottawa County GIS in October 2004. All bridges and culverts were field surveyed to obtain elevation and structural geometry.
Unnamed Tributary 2 to Buttermilk Creek	Charter Township of Jamestown	Channel cross sections for backwater analyses were obtained from field surveys completed in March 2005. Overbank cross-sectional data was obtained from a DEM generated from LiDAR mass point data obtained from Ottawa County GIS in October 2004. All bridges and culverts were field surveyed to obtain elevation and structural geometry.
Vans Bypass	Charter Township of Holland	Channel cross sections for backwater analyses were obtained from field surveys completed in May 2005. Overbank cross-sectional data was obtained from a DEM generated from LiDAR mass point data obtained from Ottawa County GIS in October 2004. All bridges and culverts were field surveyed to obtain elevation and structural geometry.
Watson Drain	Charter Township of Georgetown	Channel cross sections for backwater analyses were obtained by field survey. Overbank cross-sectional data was obtained from a 1976 aerial topographic map (Reference 64). All bridges and culverts were field surveyed to obtain elevation and structural geometry.
Windmill Creek	Charter Township of Holland	Channel cross sections for backwater analyses were obtained from field surveys completed in May 2005. Overbank cross-sectional data was obtained from a DEM generated from LiDAR mass point data obtained from Ottawa County GIS in February 2005. All bridges and culverts were field surveyed to obtain elevation and structural geometry.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the FIRM.

Water-surface elevations for all streams previously studied by detailed methods, which are listed in TABLE 3, were calculated using the USACE HEC-2 step-backwater computer program (Reference 65). Water-surface elevations for all streams newly studied or restudied by detailed methods, which are listed in TABLE 4, were calculated using the USACE HEC-RAS step-backwater computer program (Reference 55). Both computer programs calculate water-surface profiles for steady, gradually varied flow based on the solution of the one-dimensional energy equation.

The methods for determining starting water-surface elevations used in each hydraulic model are described in TABLE 10 (References 1–10, 12–14, 16–19, and 28–38).

TABLE 10 – Starting Water-Surface Elevations

Flooding Source	Location	Method for Determining Starting WSE
Alward Drain	Charter Township of Georgetown	HEC-RAS normal depth routines
Bareman Drain	Charter Township of Holland	Obtained from flood elevations at confluence with County Drain No. 15 & 17
Bliss Creek Intercounty Drain	Charter Township of Georgetown	HEC-RAS normal depth routines
Bliss Drain Diversion Channel	Charter Township of Georgetown	Obtained from flood elevations at confluence with Bliss Creek Intercounty Drain
Brower & No. 39 Drain	Charter Township of Holland	Obtained from flood elevations at confluence with Hunters Creek
Buttermilk Creek	City of Hudsonville	HEC-RAS normal depth routines
Comstock Drain	Charter Township of Georgetown	Slope-area method (normal depth)
County Drain No. 8 and North Holland Drain	Charter Township of Holland	Obtained from flood elevations at confluence with County Drain No. 40
County Drain No. 15 & 17	Charter Township of Holland	Obtained from flood elevations at confluence with County Drain No. 40
County Drain No. 28	Charter Township of Holland	HEC-RAS normal depth routines
County Drain No. 40	Charter Township of Holland	Obtained from flood elevations at confluence with Windmill Creek
Deer Creek	City of Cooperville	Critical depth
DeWeerd Drain	Charter Township of Georgetown	HEC-RAS normal depth routines

TABLE 10 – Starting Water-Surface Elevations *(continued)*

Flooding Source	Location	Method for Determining Starting WSE
Grand River	City of Grand Haven	Obtained from the mean lake level of Lake Michigan
	Charter Township of Allendale	Obtained from a discharge-elevation rating curve for the stream gage at Eastmanville (USGS gage no. 04119300)
Hager Creek	Charter Township of Georgetown	Slope-area method (normal depth)
Harlem Ext. Drain / Harlem Drain	Township of Park	Obtained from the mean lake level of Lake Macatawa
Huizenga Intercounty Drain	Charter Township of Georgetown	HEC-RAS normal depth routines
Hunters Creek	Charter Township of Holland	Obtained from flood elevations at confluence with Noordeloos Creek
Knight Intercounty Drain	Charter Township of Georgetown	Obtained from flood elevations at confluence with Bliss Creek Intercounty Drain
Macatawa River	Charter Township and City of Holland	Obtained from the mean lake level of Lake Macatawa
Meadowbrook Drain	Charter Township of Georgetown	HEC-RAS normal depth routines
Noordeloos Creek	Charter Township of Holland	Critical depth
Northwest Branch of Rush Creek	Charter Township of Georgetown	Obtained from flood elevations at confluence with Rush Creek
Ottawa Creek & Ext. Drain / Ottawa Drain/ Curry Drain	Charter Township of Allendale	Slope-area method (normal depth)
Rush Creek	Charter Township of Georgetown	HEC-RAS normal depth routines
Trout Drain	Charter Township of Georgetown	HEC-RAS normal depth routines
Tulip Intercounty Drain	Charter Township of Holland	Critical depth
Unnamed Tributary 1 to Buttermilk Creek	City of Hudsonville	Obtained from flood elevations at confluence with Buttermilk Creek
Unnamed Tributary 2 to Buttermilk Creek	Charter Township of Jamestown	Obtained from flood elevations at confluence with Buttermilk Creek
Vans Bypass	Charter Township of Holland	Obtained from flood elevations at confluence with Bareman Drain
Watson Drain	Charter Township of Georgetown	Slope-area method (normal depth)
Windmill Creek	Charter Township of Holland	HEC-RAS normal depth routines

Roughness coefficients (Manning's "n" values) were used to compute the hydraulic conveyance of each cross section and to compute friction losses between adjacent sections. Roughness coefficients were chosen by engineering judgment and based on field observations of the stream and floodplain areas. TABLE 11 shows the channel and overbank "n" values for the flooding sources studied by detailed methods (References 1–10, 12–14, 16–19, and 28–38).

TABLE 11 – Manning's "n" Values

Flooding Source and Location	Channel "n" Values	Overbank "n" Values
Alward Drain		
Charter Township of Georgetown	0.025–0.030	0.025–0.040
Bareman Drain		
Charter Township of Holland	0.030–0.045	0.017–0.100
Bliss Creek Intercounty Drain		
Charter Township of Georgetown	0.020–0.035	0.035–0.120
Bliss Creek Intercounty Drain Diversion Channel		
Charter Township of Georgetown	0.017–0.040	0.040–0.050
Brower & No. 39 Drain		
Charter Township of Holland	0.040–0.045	0.030–0.100
Buttermilk Creek		
Charter Township of Jamestown and City of Hudsonville	0.025–0.060	0.025–0.080
Comstock Drain		
Charter Township of Georgetown	0.035–0.045	0.040–0.070
County Drain No. 8 and North Holland Drain		
Charter Township of Holland	0.025–0.080	0.030–0.100
County Drain No. 15 & 17		
Charter Township of Holland	0.025–0.035	0.025–0.080
County Drain No. 28		
Charter Township of Holland	0.030–0.055	0.025–0.120
County Drain No. 40		
Charter Township of Holland	0.030–0.045	0.016–0.100
Deer Creek		
City of Coopersville	0.030–0.050	0.030–0.150
DeWeerd Drain		
Charter Townships of Georgetown and Jamestown and City of Hudsonville	0.030–0.050	0.030–0.100

TABLE 11 – Manning's "n" Values *(continued)*

Flooding Source and Location	Channel "n" Values	Overbank "n" Values
Grand River		
Charter Townships of Allendale[1], Georgetown[1], and Tallmadge[1]	0.030–0.043	0.040–0.150
Charter Townships of Allendale[2], Georgetown[3], and Tallmadge[4]	0.030–0.035	0.060–0.110
Charter Townships of Allendale[5], Grand Haven[6], Polkton, and Tallmadge[5] and Townships of Crockery, Robinson, and Spring Lake[6]	0.030	0.040–0.100
City of Ferrysburg	0.035	0.090–0.105
City of Grand Haven	0.026–0.039	0.015–0.090
Charter Township of Grand Haven[7]	0.035–0.050	0.050–0.100
Township of Spring Lake[7]	0.035–0.039	0.045–0.060
Village of Spring Lake	0.035–0.039	0.045–0.060
Hager Creek		
Charter Township of Georgetown	0.035–0.040	0.050–0.060
Harlem Drain		
Charter Township of Holland	0.035–0.045	0.050
Harlem Ext. Drain		
Township of Park	0.019–0.045	0.020–0.100
Huizenga Intercounty Drain		
Charter Township of Georgetown	0.030–0.035	0.025–0.100
Hunters Creek		
Charter Township of Holland	0.040–0.045	0.030–0.100

1 Upstream of a point approximately 1.8 miles upstream of the eastbound Lake Michigan Drive bridge

2 Upstream of a point approximately 800 feet downstream of the westbound Lake Michigan Drive bridge

3 Downstream of a point approximately 1.8 miles upstream of the eastbound Lake Michigan Drive bridge

4 Upstream of a point approximately 800 feet downstrem of the westbound Lake Michigan Drive bridge and downstream of a point approximately 1.8 miles upstream of the eastbound Lake Michigan Drive bridge

5 Downstream of a point approximately 800 feet downstream of the westbound Lake Michigan Drive bridge

6 Upstream of a point approximately 0.4 mile downstream of the Township of Spring Lake / Township of Crockery and Township of Robinson / Charter Township of Grand Haven corporate limits

7 Downstream of a point approximately 0.4 mile downstream of the Township of Spring Lake / Township of Crockery and Township of Robinson / Charter Township of Grand Haven corporate limits

TABLE 11 – Manning's "n" Values (continued)

Flooding Source and Location	Channel "n" Values	Overbank "n" Values
Knight Intercounty Drain		
Charter Townships of Georgetown and Jamestown	0.030–0.040	0.030–0.120
Macatawa River / Black Creek of Zeeland Drain		
Charter Township and City of Holland	0.023–0.035	0.025–0.120
Meadowbrook Drain		
Charter Township of Georgetown	0.025–0.048	0.025–0.085
Noordeloos Creek		
Charter Township of Holland	0.035–0.045	0.035–0.100
Northwest Branch of Rush Creek		
Charter Township of Georgetown	0.030–0.040	0.016–0.100
Ottawa Creek & Ext. Drain / Ottawa Drain / Curry Drain		
Charter Township of Allendale	0.030–0.035	0.030–0.070
Rush Creek		
Charter Township of Georgetown and City of Hudsonville	0.030–0.040	0.011–0.080
South Channel		
City of Grand Haven	0.040	not available[8]
Trout Drain		
Charter Township of Georgetown and City of Hudsonville	0.025–0.040	0.030–0.100
Tulip Intercounty Drain		
Charter Township of Holland	0.045	0.035–0.100
Unnamed Tributary 1 to Buttermilk Creek		
City of Hudsonville	0.030–0.050	0.025–0.120
Unnamed Tributary 2 to Buttermilk Creek		
Charter Township of Jamestown	0.030–0.035	0.030–0.100
Vans Bypass		
Charter Township of Holland	0.025–0.040	0.025–0.080
Watson Drain		
Charter Township of Georgetown	0.030–0.040	0.030–0.050
Windmill Creek		
Charter Township of Holland	0.033–0.045	0.025–0.100

8 Due to the parameters of this study, limited information regarding the data used in previously-completed studies is available.

Special consideration was given to South Channel. This reach was analyzed as an island flow problem in the Grand River HEC-2 model prepared for the 1977 City of Grand Haven FIS (Reference 5).

Detail-studied streams that were not restudied as part of this map update may include a "profile base line" on the maps. This "profile base line" provides a link to the flood profiles included in this FIS. The detail-studied stream centerlines may have been digitized or redelineated as part of this revision. The "profile base lines" for these streams were based on the best available data at the time of their study and are depicted as they were on the previous FIRMs. In some cases where improved topographic data was used to redelineate floodplain boundaries, the "profile base line" may deviate significantly from the channel centerline or may be outside the SFHA.

The hydraulic analyses for this study are based only on the effects of unobstructed flow. The flood elevations as shown on the profiles (Exhibit 1) are, therefore, considered valid only if hydraulic structures, in general, remain unobstructed and if channel and overbank conditions remain essentially the same as ascertained during this study.

Flood profiles were drawn showing the computed water-surface elevations to an accuracy of 0.5 foot for floods of the selected recurrence intervals. In cases where two or more profiles are close together, due to limitations of the profile scale, only the higher profile has been shown. Please note that profiles for South Channel and the portion of the Grand River where the 1-percent-annual-chance flood elevations are controlled by backwater from Lake Michigan are not presented in this study.

Cross sections for the streams studied by approximate methods were extracted from a 2003 Digital Terrain Model (DTM) obtained from the Regional Geographic Information System (REGIS) (Reference 64). This DTM has a mapping scale of 1:1200 and is capable of generating 2-foot contours. Water-surface elevations for the 1-percent-annual-chance flood were computed using the HEC-RAS computer program. Known water-surface elevations, when available, were used for the downstream reach boundary condition. For streams without a known downstream water-surface elevation, the starting water-surface elevations were computed as normal depth in HEC-RAS. Downstream gradients were estimated though the use of USGS topographic maps. Manning's "n" values were estimated based on field observations, visual observation of aerial photography, and standard, accepted values published in *Open-Channel Hydraulics* by V.T. Chow (Reference 61). Separate overbank and channel roughness values were selected for each cross section.

All elevations are referenced from NAVD88; elevation reference marks used in the study are shown on the maps.

May 16, 2013
Revised Countywide FIS

For the May 16, 2013, revision, the revised detailed study for the reach of the Grand River extending from a point approximately 0.8 mile downstream of Lake Michigan Drive to a point approximately 4.4 miles upstream of Lake Michigan Drive was modeled using the HEC-RAS computer program (version 4.1.0). The starting water-surface elevations the 1- and 0.2-percent-annual-chance flood events were obtained from the previously published flood profiles for the Grand River at a point approximately 0.8 mile downstream of the westbound Lake Michigan Drive bridge. The starting water-surface elevations for the 10- and 2- percent-annual-chance flood events were computed as normal depth. Information on cross section data and Manning's "n" values can be found in Tables 9 and 11, respectively.

3.3 Vertical Datum

All FIS reports and FIRMs are referenced to a specific vertical datum. The vertical datum provides a starting point against which flood, ground, and structure elevations can be referenced and compared. Until recently, the standard vertical datum in use for newly created or revised FIS reports and FIRMs was the National Geodetic Vertical Datum of 1929 (NGVD29). With the finalization of the North American Vertical Datum of 1988 (NAVD88), many FIS reports and FIRMs are being prepared using NAVD88 as the referenced vertical datum.

Effective information for this countywide FIS report was converted from NGVD29 to NAVD88 based on data presented in TABLE 12. The average conversion of NGVD29-0.467=NAVD88 was applied to convert all effective Base Flood Elevations (BFEs). Structure and ground elevations in the community must, therefore, be referenced to NAVD88. It is important to note that adjacent communities in other counties not presented in this countywide FIS may be referenced to NGVD29. This may result in differences in BFEs across the corporate limits between communities.

TABLE 12 – Datum Conversion Calculations

Quadrangle Name	Quadrangle Corner	Latitude	Longitude	Difference
Muskegon West	SE	43.125	-86.250	-0.456 ft
Muskegon East	SE	43.125	-86.125	-0.456 ft
Sullivan	SE	43.125	-86.000	-0.456 ft
Ravenna	SE	43.125	-85.875	-0.440 ft
Casnovia	SE	43.125	-85.750	-0.423 ft
Grand Haven OE W	SE	43.000	-86.250	-0.476 ft
Coopersville	SE	43.000	-85.875	-0.463 ft
Coopersville	SW	43.000	-86.000	-0.472 ft
Grand Haven	SE	43.000	-86.125	-0.476 ft
Marne	SE	43.000	-85.750	-0.446 ft
Port Sheldon	SE	42.875	-86.125	-0.495 ft
Port Sheldon	SW	42.875	-86.250	-0.486 ft
Allendale	SE	42.875	-85.875	-0.463 ft
Allendale	SW	42.875	-86.000	-0.469 ft
Grandville	SE	42.875	-85.750	-0.459 ft
Holland West	SE	42.750	-86.125	-0.541 ft
Holland West	SW	42.750	-86.250	-0.509 ft
Holland East	SE	42.750	-86.000	-0.463 ft
Hudsonville West	SE	42.750	-85.875	-0.446 ft
Hudsonville East	SE	42.750	-85.750	-0.446 ft

Average Conversion	-0.467
Range	-0.541 to -0.423
Max Offset	0.074

For more information on NAVD88, see the FEMA publication entitled *Converting the National Flood Insurance Program to the North American Vertical Datum of 1988: Guidelines for Community Officials, Engineers, and Surveyors* (Reference 66), or contact the Vertical Network Branch, National Geodetic Survey, Coast and Geodetic Survey, National Oceanic and Atmospheric Administration, Silver Spring, Maryland 20910 (http://www.ngs.noaa.gov).

Temporary vertical monuments are often established during the preparation of a flood hazard analysis for the purpose of establishing local vertical control. Although these monuments are not shown on the FIRM, they may be found in the TSDN associated with this countywide FIS report and FIRM for this community. Interested individuals may contact FEMA to access these data.

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages state and local governments to adopt sound floodplain management programs. Therefore, each FIS provides l-percent-annual-chance flood elevations and delineations of the 1- and 0.2-percent-annual-chance floodplain boundaries and l-percent-annual-chance floodway to assist communities in developing floodplain management measures. This information is presented on the FIRM and in many components of this countywide FIS report, including Flood Profiles, Floodway Data table, and Summary of Stillwater Elevations table. Users should reference the data presented in this countywide FIS report as well as additional information that may be available at the local map repository before making flood elevation and/or floodplain boundary determinations.

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent-annual-chance flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent-annual-chance flood is employed to indicate additional areas of flood risk in the community. For each stream studied by detailed methods, the 1- and 0.2-percent-annual-chance floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using a DTM with a contour interval of 2 feet (Reference 64).

The 1- and 0.2-percent-annual-chance floodplain boundaries are shown on the FIRM. On this map, the l-percent-annual-chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A and AE); and the 0.2-percent-annual-chance floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 1- and 0.2-percent-annual-chance floodplain boundaries are close together, only the l-percent-annual-chance floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

For the streams studied by approximate methods, only the l-percent-annual-chance floodplain boundary is shown on the FIRM. For lakes designated as Zone A, the floodplains were delineated using the 1-percent-annual-chance pool elevation, which was obtained from MDEQ, if available. Otherwise, they were digitized to the nearest contour and checks were made to see that the elevations fall between the normal pool and the top of dam elevations.

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the NFIP, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the l-percent-annual-chance floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the l-percent-annual-chance flood can be carried without substantial increases in flood heights. Minimum federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

The floodway presented in this countywide FIS report and on the FIRM was computed for certain stream segments on the basis of equal conveyance reduction from each side of the floodplain. Floodway widths were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. The results of the floodway computations have been tabulated for selected cross sections. In cases where the floodway and l-percent-annual-chance floodplain boundaries are either close together or collinear, only the floodway boundary has been shown.

The area between the floodway and l-percent-annual-chance floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water surface elevation of the l-percent-annual-chance flood more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in FIGURE 1.

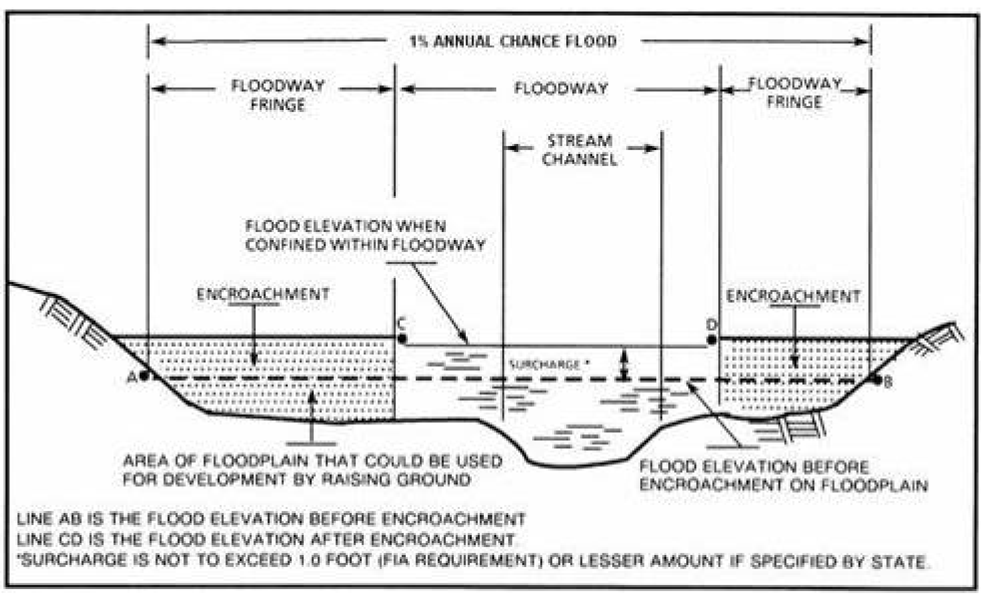

FIGURE 1 – Floodway Schematic

In Michigan, under the state's Floodplain Regulatory Authority, found in Part 31 of the Natural Resources and Environmental Protection Act, 1994 PA 451, (Reference 67), encroachment in the floodplain is limited to that which will cause only insignificant increases in flood heights. At the recommendation of MDEQ, Land and Water Management Division, a floodway having no more than a 0.1-foot surcharge has been delineated for this countywide FIS.

The floodways presented in this study were initially computed on the basis of equal conveyance reduction from each side of the flood plain. In those areas where problems arose with the equal conveyance reduction encroachment option of the HEC-2 or HEC-RAS backwater programs, modifications were applied based on experience.

Please note that for Alward Drain from the downstream private drive to a point approximately 500 feet upstream, a floodway having no more than a 0.1-foot surcharge could not be realized. Based on engineering judgment, floodway encroachments were instead set at the top of bank (Reference 28).

In the redelineation efforts, the floodways were not recalculated. As a result, there were areas where the previous floodway did not fit within the boundaries of the redelineated 1-percent-annual-chance floodplain. In these areas, the floodway was reduced. Water-surface elevations, both with and without a floodway, the mean velocity in the floodway and the location and area at each surveyed cross section as determined by hydraulic methods can be seen in TABLE 13, Floodway Data. The width of the floodway depicted by the FIRM panels and the amount of reduction to fit the floodway inside the 1-percent-annual-chance floodplain, if necessary, is also listed.

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
ALWARD DRAIN									
A	493	63	232	1.7		615.8	615.8	616.2	0.4[2]
B	1,729	16	42	9.2		617.2	617.2	617.3	0.1
C	1,770	8	34	11.6		618.9	618.9	619.0	0.1
D	1,853	91	194	2.0		623.3	623.3	623.4	0.1

[1] Feet above confluence with Rush Creek

[2] A surcharge of 0.1 foot or less could not be obtained using standard methods in HEC-RAS. Based on engineering judgment, the floodway encroachments were set equal to the top of bank to create the most accurate floodway possible.

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

ALWARD DRAIN

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
BAREMAN DRAIN									
A	29	36	165	1.7		614.6	614.6	614.7	0.1
B	477	27	131	2.1		614.7	614.7	614.8	0.1
C	1,182	22	163	1.7		617.3	617.3	617.4	0.1
D	1,410	96	419	0.6		619.5	619.5	619.5	0.0
E	1,510	145	711	0.4		619.5	619.5	619.5	0.0
F	2,107	24	120	2.2		619.5[2]	619.5[2]	619.5	0.0
G	3,271	137	392	0.7		621.6	621.6	621.6	0.0
H	4,621	44	93	2.9		623.3	623.3	623.3	0.0
I	4,753	11	54	5.0		624.0	624.0	624.1	0.1
J	4,785	87	137	2.0		625.3	625.3	625.3	0.0
K	4,946	157	208	1.3		625.6	625.6	625.6	0.0
L	5,279	139	213	1.3		625.8	625.8	625.8	0.0
M	5,745	257	317	0.9		626.0	626.0	626.0	0.0
N	5,872	256	445	0.6		626.8	626.8	626.8	0.0
O	6,003	330	282	0.5		626.8	626.8	626.8	0.0
P	6,454	260	472	0.3		626.8	626.8	626.8	0.0
Q	8,209	38	63	2.4		629.9	629.9	629.9	0.0
R	8,381	429	504	0.3		630.9	630.9	631.0	0.1
S	9,389	136	144	1.0		631.0	631.0	631.0	0.0
T	9,585	391	1,085	0.1		632.6	632.6	632.6	0.0

[1] Feet above confluence with County Drain No. 15 & 17

[2] Elevation computed at downstream cross section applied to eliminate drawdown

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

BAREMAN DRAIN

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
BLISS CREEK INTERCOUNTY DRAIN									
A	1,690	76	345	6.3		609.2	609.2	609.3	0.1
B	1,790	80	355	6.1		609.4	609.4	609.5	0.1
C	1,865	73	446	4.9		610.0	610.0	610.0	0.0
D	2,050	45	243	8.9		610.9	610.9	610.9	0.0
E	2,150	68	302	7.2		611.6	611.6	611.6	0.0
F	2,250	125	545	4.0		612.3	612.3	612.3	0.0
G	2,550	99	398	5.4		612.5	612.5	612.5	0.0
H	2,735	90	406	5.3		612.9	612.9	612.9	0.0
I	2,926	116	500	4.3		613.4	613.4	613.4	0.0
J	3,226	235	641	3.4		613.7	613.7	613.7	0.0
K	3,356	235	635	3.4		613.8	613.8	613.9	0.1
L	3,631	153	459	4.7		614.0	614.0	614.0	0.0
M	3,766	215	546	4.0		614.4	614.4	614.5	0.1
N	3,882	255	667	3.3		614.7	614.7	614.8	0.1
O	4,182	136	453	4.8		614.9	614.9	615.0	0.1
P	4,352	250	616	3.5		615.3	615.3	615.4	0.1
Q	4,673	595	1,215	1.7		615.8	615.8	615.9	0.1
R	5,258	850	1,163	1.7		616.1	616.1	616.2	0.1
S	5,957	271	506	4.0		616.4	616.4	616.5	0.1
T	6,013	247	315	6.4		616.6	616.6	616.7	0.1
U	6,203	142	264	7.7		617.1	617.1	617.2	0.1
V	6,358	180	394	5.1		618.5	618.5	618.6	0.1
W	6,608	130	249	8.2		619.2	619.2	619.2	0.0

[1] Feet above confluence with Rush Creek

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

BLISS CREEK INTERCOUNTY DRAIN

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
BLISS CREEK INTERCOUNTY DRAIN (CONTINUED)									
X	7,049	275	720	2.8		621.3	621.3	621.3	0.0
Y	7,372	339	692	2.9		621.6	621.6	621.6	0.0
Z	7,682	105	409	5.0		621.8	621.8	621.9	0.1
AA	7,802	55	205	9.9		621.8[2]	621.3	621.3	0.0
AB	7,982	232	795	4.5		622.7	622.7	622.8	0.1
AC	8,582	320	847	2.4		623.6	623.6	623.7	0.1
AD	8,782	166	621	4.9		623.6[2]	623.6[2]	623.6	0.0
AE	9,237	137	380	5.3		624.3	624.3	624.4	0.1
AF	9,437	130	466	4.4		625.0	625.0	625.0	0.0
AG	9,637	176	445	4.6		625.3	625.3	625.3	0.0
AH	9,867	18	114	2.5		626.0	626.0	626.0	0.0
AI	11,802	19	157	3.5		630.2	630.2	630.3	0.1
AJ	11,822	66	418	1.3		632.6	632.6	632.7	0.1
AK	11,972	245	1,297	2.1		632.6	632.6	632.6	0.0
AL	12,278	260	1,510	2.0		632.7	632.7	632.7	0.0
AM	12,693	134	716	2.9		632.8	632.8	632.9	0.1
AN	12,962	76	530	4.0		633.1	633.1	633.2	0.1
AO	13,188	75	654	3.2		634.4	634.4	634.5	0.1
AP	13,805	127	821	2.6		634.7	634.7	634.8	0.1
AQ	14,170	52	397	5.3		634.8	634.8	634.9	0.1
AR	14,231	74	318	6.6		634.8	634.8	634.9	0.1
AS	14,359	141	721	2.9		635.8	635.8	635.8	0.0

[1] Feet above confluence with Rush Creek

[2] Elevation computed at downstream cross section applied to eliminate drawdown

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

BLISS CREEK INTERCOUNTY DRAIN

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
BLISS CREEK INTERCOUNTY DRAIN (CONTINUED)									
AT	16,116	129	536	3.9		637.4	637.4	637.5	0.1
AU	16,282	171	361	5.8		637.6	637.6	637.7	0.1
AV	16,325	174	558	3.8		638.7	638.7	638.8	0.1
AW	16,536	159	690	3.0		639.0	639.0	639.1	0.1
AX	18,130	211	757	2.8		640.3	640.3	640.4	0.1
AY	18,165	194	677	3.0		640.3	640.3	640.4	0.1
AZ	18,512	143	515	3.9		640.7	640.7	640.7	0.0
BA	19,417	177	597	3.4		641.9	641.9	642.0	0.1
BB	19,901	77	316	6.3		642.8	642.8	642.9	0.1
BC	19,981	77	538	3.7		643.7	643.7	643.8	0.1
BD	20,067	249	859	2.3		643.9	643.9	644.0	0.1
BE	21,306	285	911	2.2		645.0	645.0	645.1	0.1
BF	21,435	360	1,278	1.6		645.2	645.2	645.3	0.1
BG	22,067	293	740	2.7		645.5	645.5	645.6	0.1

[1] Feet above confluence with Rush Creek

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

BLISS CREEK INTERCOUNTY DRAIN

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
BLISS CREEK INTERCOUNTY DRAIN DIVERSION CHANNEL									
A	171	18	135	13.0		626.6	626.6	626.6	0.0
B	286	18	205	8.5		631.0	631.0	631.1	0.1
C	330	52	473	3.7		632.1	632.1	632.2	0.1
D	510	63	473	3.7		632.2	632.2	632.3	0.1
E	769	95	479	3.7		632.4	632.4	632.4	0.0

[1] Feet above confluence with Bliss Creek Intercounty Drain

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

BLISS CREEK INTERCOUNTY DRAIN DIVERSION CHANNEL

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
BROWER & NO. 39 DRAIN									
A	121	98	267	2.2		621.8	621.8	621.8	0.0
B	786	114	284	2.1		622.6	622.6	622.6	0.0
C	1,246	85	120	5.0		623.4	623.4	623.4	0.0
D	1,529	15	95	6.3		625.4	625.4	625.4	0.0
E	1,634	140	523	1.1		626.3	626.3	626.3	0.0
F	1,919	37	119	5.1		626.3	626.3	626.3	0.0
G	2,919	63	182	3.3	50	629.9	629.9	629.9	0.0
H	4,039	75	161	3.7		633.2	633.2	633.2	0.0
I	4,168	13	68	8.8		633.8	633.8	633.8	0.0

[1] Feet above confluence with Hunters Creek

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

BROWER & NO. 39 DRAIN

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
BUTTERMILK CREEK									
A	1,073	35	130	9.2		614.5	613.3[2]	613.4	0.1
B	1,398	32	119	10.1		615.8	615.8	615.8	0.0
C	1,909	51	175	6.8		619.2	619.2	619.3	0.1
D	2,346	23	109	11.0		620.7	620.7	620.7	0.0
E	2,432	39	238	5.0		624.4	624.4	624.4	0.0
F	2,690	35	168	6.6		624.7	624.7	624.8	0.1
G	2,832	52	315	3.5		626.6	626.6	626.6	0.0
H	2,988	37	264	4.2		626.8	626.8	626.8	0.0
I	3,036	35	230	4.8		626.9	626.9	626.9	0.0
J	3,219	54	320	3.5		627.4	627.4	627.5	0.1
K	3,772	33	164	6.7		628.1	628.1	628.1	0.0
L	3,916	35	240	4.6		629.7	629.7	629.7	0.0
M	4,001	45	293	3.8		630.9	630.9	630.9	0.0
N	4,438	80	364	3.0		631.2	631.2	631.2	0.0
O	4,929	29	157	7.0		631.3	631.3	631.4	0.1
P	5,093	67	380	2.9		634.7	634.7	634.8	0.1
Q	5,524	200	809	1.3		634.9	634.9	635.0	0.1
R	6,590	40	207	5.1		635.6	635.6	635.7	0.1
S	6,750	32	232	4.6		635.9	635.9	636.0	0.1
T	6,899	85	411	2.6		638.0	638.0	638.1	0.1
U	7,146	218	514	2.1		638.1	638.1	638.2	0.1
V	7,219	257	548	1.9		638.7	638.7	638.8	0.1
W	7,510	181	247	4.3		638.7	638.7	638.8	0.1
X	7,571	171	364	2.9		640.3	640.3	640.4	0.1

[1] Feet above confluence with Rush Creek

[2] Elevation computed without consideration of backwater effects from Rush Creek

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI

(ALL JURISDICTIONS)

FLOODWAY DATA

BUTTERMILK CREEK

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
BUTTERMILK CREEK (CONTINUED)									
Y	7,842	43	354	3.0		640.5	640.5	640.6	0.1
Z	8,201	107	311	3.4		641.1	641.1	641.2	0.1
AA	8,531	50	230	4.6		641.6	641.6	641.6	0.0
AB	8,716	138	361	2.9		642.0	642.0	642.0	0.0
AC	8,791	166	428	2.5		642.4	642.4	642.5	0.1
AD	8,904	145	466	2.0		642.6	642.6	642.6	0.0
AE	10,559	72	162	5.7		645.3	645.3	645.3	0.0
AF	10,751	100	292	3.9		646.9	646.9	647.0	0.1
AG	10,841	102	322	3.3		647.8	647.8	647.9	0.1
AH	10,898	110	441	2.1		648.0	648.0	648.1	0.1
AI	12,141	31	134	6.9		648.5	648.5	648.6	0.1
AJ	12,277	66	302	3.1		650.5	650.5	650.5	0.0
AK	12,683	30	180	2.3		650.9	650.9	651.0	0.1
AL	14,024	32	121	3.3		651.4	651.4	651.4	0.0
AM	14,151	20	98	4.1		651.5	651.5	651.5	0.0
AN	14,276	40	136	3.0		652.6	652.6	652.6	0.0
AO	14,487	29	116	1.8		652.9	652.9	652.9	0.0
AP	15,102	61	135	1.5		653.1	653.1	653.1	0.0
AQ	15,482	19	57	3.7		653.5	653.5	653.5	0.0
AR	15,732	22	73	2.8		654.0	654.0	654.1	0.1
AS	16,076	70	101	2.1		660.0	660.0	660.0	0.0
AT	16,129	47	70	3.0		660.0	660.0	660.0	0.0
AU	16,260	8	28	7.3		660.0	660.0	660.1	0.1

[1] Feet above confluence with Rush Creek

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

BUTTERMILK CREEK

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
BUTTERMILK CREEK (CONTINUED)									
AV	16,371	45	193	1.1		664.2	664.2	664.2	0.0
AW	16,494	21	135	1.5		664.2	664.2	664.2	0.0
AX	16,654	395	3,285	0.3		672.9	672.9	672.9	0.0
AY	17,149	579	4,077	0.1		672.9	672.9	672.9	0.0
AZ	18,322	280	1,325	0.3		672.9	672.9	672.9	0.0
BA	19,146	130	482	0.7		672.9	672.9	672.9	0.0
BB	20,355	80	172	10.3		677.0	677.0	677.0	0.0
BC	20,434	103	939	0.4		684.9	684.9	684.9	0.0

[1] Feet above confluence with Rush Creek

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

BUTTERMILK CREEK

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
COMSTOCK DRAIN									
A	2,650	56	75	4.4		601.5	598.2[2]	598.3	0.1
B	3,103	20	64	5.2		601.5	600.4[2]	600.5	0.1
C	4,065	25	64	5.2		603.0	603.0	603.0	0.0
D	6,425	19	135	2.1		607.0	607.0	607.0	0.0
E	8,645	21	132	2.2		609.4	609.4	609.4	0.0
F	10,670	144	251	3.2		611.5	611.5	611.5	0.0
G	12,940	18	124	5.6		622.4	622.4	622.4	0.0
H	14,070	100	387	1.8		625.6	625.6	625.6	0.0
I	14,631	267	677	1.0		625.8	625.8	625.8	0.0
J	14,845	252	892	0.8	103	625.9	625.9	625.9	0.0
K	15,585	72	132	5.2		626.6	626.6	626.7	0.1
L	16,095	90	256	2.7		628.8	628.8	628.9	0.1
M	18,331	76	208	1.4	65	634.1	634.1	634.1	0.0
N	19,120	180	700	0.4		636.2	636.2	636.2	0.0

[1] Feet above confluence with Grand River

[2] Elevation computed without consideration of backwater effects from Grand River

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

COMSTOCK DRAIN

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
COUNTY DRAIN NO. 8 AND NORTH HOLLAND DRAIN									
A	35	43	208	1.1		611.3	611.3	611.4	0.1
B	1,013	28	122	1.9		611.5	611.5	611.6	0.1
C	1,287	16	74	3.1		611.7	611.7	611.8	0.1
D	1,501	20	76	3.0		612.1	612.1	612.1	0.0
E	1,769	17	81	2.9		612.4	612.4	612.5	0.1
F	2,441	18	89	2.6		613.2	613.2	613.3	0.1
G	2,554	30	176	1.3		613.3	613.3	613.4	0.1
H	2,695	64	79	2.9		613.7	613.7	613.7	0.0
I	3,147	76	101	2.3		614.2	614.2	614.2	0.0
J	3,659	110	150	1.5		614.9	614.9	615.0	0.1
K	3,827	21	120	1.9		615.0	615.0	615.1	0.1
L	3,936	26	98	2.3		615.1	615.1	615.1	0.0
M	4,182	25	136	1.7		615.2	615.2	615.3	0.1
N	4,273	28	122	1.9		615.3	615.3	615.4	0.1
O	4,493	55	248	0.9		615.3	615.3	615.4	0.1
P	4,990	60	232	1.0		615.4	615.4	615.5	0.1
Q	5,059	42	192	1.2		615.5	615.5	615.6	0.1
R	5,353	62	222	1.0		615.5	615.5	615.6	0.1
S	5,891	28	120	1.9		615.6	615.6	615.7	0.1
T	6,071	16	56	4.1		615.7	615.7	615.8	0.1
U	6,671	24	88	2.5		617.3	617.3	617.3	0.0
V	7,277	141	228	1.0		617.6	617.6	617.7	0.1
W	8,382	62	217	1.0		617.8	617.8	617.9	0.1

[1] Feet above confluence with County Drain No. 15 & 17 and County Drain No. 40

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

COUNTY DRAIN NO. 8 AND NORTH HOLLAND DRAIN

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
COUNTY DRAIN NO. 8 AND NORTH HOLLAND DRAIN (CONTINUED)									
X	8,679	19	82	2.7		617.8	617.8	617.9	0.1
Y	8,733	32	142	1.6		618.8	618.8	618.9	0.1
Z	9,135	48	171	1.3		618.9	618.9	619.0	0.1
AA	9,573	20	82	2.7		619.1	619.1	619.2	0.1
AB	9,743	44	148	1.5		619.3	619.3	619.4	0.1
AC	10,230	25	83	2.6		619.8	619.8	619.8	0.0
AD	10,677	16	60	3.6		621.2	621.2	621.2	0.0
AE	10,850	16	68	3.2		622.2	622.2	622.2	0.0
AF	10,989	23	77	2.9		622.6	622.6	622.6	0.0
AG	11,265	32	81	2.7		623.1	623.1	623.2	0.1
AH	11,482	65	262	1.3		624.5	624.5	624.6	0.1

[1] Feet above confluence with County Drain No. 15 & 17 and County Drain No. 40

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

COUNTY DRAIN NO. 8 AND NORTH HOLLAND DRAIN

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
COUNTY DRAIN NO. 15 & 17									
A	64	30	182	3.3		611.3	611.3	611.4	0.1
B	1,191	31	132	4.6		612.5	612.5	612.6	0.1
C	1,367	38	209	2.9		613.4	613.4	613.4	0.0
D	1,674	91	170	3.5	23	613.6	613.6	613.6	0.0
E	2,461	23	133	4.5		614.6	614.6	614.7	0.1
F	3,885	134	203	2.6		616.3	616.3	616.3	0.0
G	3,991	78	212	2.5		616.8	616.8	616.9	0.1
H	4,144	122	274	1.9		617.0	617.0	617.0	0.0
I	4,338	21	152	3.5		617.3	617.3	617.4	0.1
J	4,901	26	125	4.2		617.9	617.9	618.0	0.1
K	5,415	56	158	3.3		618.5	618.5	618.6	0.1
L	6,333	47	158	3.5		619.2	619.2	619.3	0.1

[1] Feet above confluence with County Drain No. 8 and North Holland Drain and County Drain No. 40

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

COUNTY DRAIN NO. 15 & 17

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
COUNTY DRAIN NO. 28									
A	396	49	158	2.2		592.6	589.1[2]	589.1	0.0
B	598	51	192	1.8		592.6	589.2[2]	589.3	0.1
C	702	22	65	5.3		592.6	589.2[2]	589.3	0.1
D	821	16	84	4.0		592.6	591.2[2]	591.2	0.0
E	935	34	115	3.0		592.6	591.6[2]	591.6	0.0
F	1,239	37	108	3.1		592.6	592.6	592.7	0.1
G	1,364	49	141	2.4		593.1	593.1	593.2	0.1
H	1,520	16	61	5.6		593.2	593.2	593.3	0.1
I	1,700	56	128	2.7		595.1	595.1	595.1	0.0
J	2,111	22	63	5.4		597.3	597.3	597.4	0.1
K	2,383	17	68	5.0		599.6	599.6	599.7	0.1
L	2,485	30	128	2.7		601.4	601.4	601.4	0.0
M	2,888	76	126	2.5		601.7	601.7	601.8	0.1
N	3,293	52	88	3.6		602.6	602.6	602.7	0.1
O	3,741	50	115	2.8		604.6	604.6	604.7	0.1
P	4,190	50	124	2.6		606.2	606.2	606.3	0.1
Q	4,268	16	64	5.0		606.3	606.3	606.4	0.1
R	4,377	26	87	3.7		606.7	606.7	606.8	0.1
S	4,443	82	193	1.7		607.1	607.1	607.2	0.1

[1] Feet above confluence with County Drain No. 40 and Windmill Creek
[2] Elevation computed without consideration of backwater effects from Macatawa River

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

COUNTY DRAIN NO. 28

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
COUNTY DRAIN NO. 40									
A	319	21	98	9.2		592.6	591.5[2]	591.5	0.0
B	467	75	216	4.2		593.6	593.6	593.6	0.0
C	1,510	51	251	3.6		596.2	596.2	596.2	0.0
D	2,560	93	332	2.7		597.4	597.4	597.5	0.1
E	3,921	36	175	5.1		600.5	600.5	600.5	0.0
F	4,041	33	184	4.9		600.9	600.9	601.0	0.1
G	4,142	153	332	2.7		602.0	602.0	602.1	0.1
H	4,229	173	529	1.7		602.2	602.2	602.3	0.1
I	5,530	67	240	3.4		603.9	603.9	604.0	0.1
J	6,960	70	283	2.9		607.9	607.9	608.0	0.1
K	7,093	57	274	3.0		608.1	608.1	608.2	0.1
L	7,240	120	371	2.2		609.6	609.6	609.7	0.1
M	8,271	103	399	1.9		610.6	610.6	610.7	0.1
N	9,173	54	290	2.6		611.3	611.3	611.4	0.1

[1] Feet above confluence with County Drain No. 28 and Windmill Creek

[2] Elevation computed without consideration of backwater effects from Macatawa River

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

COUNTY DRAIN NO. 40

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
DEER CREEK									
A	0	66	363	5.5		614.2	614.2	614.2	0.0
B	110	220	1,047	1.9		614.8	614.8	614.8	0.0
C	670	302	1,918	1.0		615.0	615.0	615.0	0.0
D	1,810	249	1,522	1.3	30	615.2	615.2	615.2	0.0
E	3,390	208	1,303	1.5		615.6	615.6	615.6	0.0
F	3,703	84	551	3.6		615.8	615.8	615.8	0.0
G	3,818	229	1,181	1.7	71	616.0	616.0	616.0	0.0
H	4,549	437	1,639	1.2		616.5	616.5	616.5	0.0
I	4,799	74	350	5.7		616.6	616.6	616.6	0.0
J	5,175	60	411	4.9		617.5	617.5	617.5	0.0
K	5,290	156	785	2.5	95	617.6	617.6	617.6	0.0
L	6,770	275	1,665	1.2	36	618.9	618.9	618.9	0.0
M	7,111	57	414	4.8		618.9	618.9	618.9	0.0
N	7,221	227	864	2.3		619.2	619.2	619.2	0.0
O	7,991	412	1,494	1.3	34	620.0	620.0	620.0	0.0
P	8,751	330	1,357	1.5	43	620.3	620.3	620.3	0.0
Q	10,001	404	1,377	1.5		620.9	620.9	620.9	0.0
R	10,821	391	1,252	1.6		621.4	621.4	621.4	0.0
S	11,054	39	273	7.3		621.4	621.4	621.4	0.0
T	11,250	48	195	10.3	52	621.9	621.9	621.9	0.0
U	11,421	290	1,841	1.1		624.1	624.1	624.1	0.0
V	12,031	353	1,465	1.4		624.1	624.1	624.1	0.0
W	13,531	331	1,249	1.4		624.3	624.3	624.3	0.0
X	13,792	37	244	7.3		624.7	624.7	624.7	0.0
Y	13,930	398	1,950	0.9		625.8	625.8	625.8	0.0

[1] Feet above Interstate 96

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

DEER CREEK

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
DEER CREEK (CONTINUED)									
Z	15,805	376	737	2.4		626.4	626.4	626.4	0.0

[1] Feet above Interstate 96

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

DEER CREEK

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
DEWEERD DRAIN									
A	1,659	134	315	2.5		610.4	610.1	610.2	0.1
B	2,859	130	356	1.7		611.8	611.8	611.9	0.1
C	3,561	35	134	3.7		612.1	612.1	612.2	0.1
D	3,672	65	269	1.9		612.6	612.6	612.6	0.0
E	3,785	149	651	0.8		612.6	612.6	612.7	0.1
F	5,070	40	66	7.6		613.1	613.1	613.1	0.0
G	5,864	380	424	1.4		615.2	615.2	615.3	0.1
H	6,128	416	337	1.5		615.4	615.4	615.5	0.1
I	6,221	410	1,031	0.5		616.9	616.9	617.0	0.1
J	6,323	250	458	1.1		616.9	616.9	617.0	0.1
K	7,490	32	30	5.0		617.1	617.1	617.1	0.0
L	9,158	15	45	3.4		623.7	623.7	623.7	0.0
M	9,325	13	28	5.4		624.3	624.3	624.4	0.1
N	9,478	11	20	7.7		628.2	628.2	628.2	0.0
O	9,565	22	55	2.7		630.0	630.0	630.0	0.0
P	10,613	16	61	2.5		633.9	633.9	633.9	0.0
Q	12,530	15	49	3.1		644.9	644.9	645.0	0.1
R	12,607	19	51	3.0		645.2	645.2	645.3	0.1
S	12,731	16	52	2.9		646.3	646.3	646.3	0.0
T	12,806	48	80	1.9		646.5	646.5	646.5	0.0
U	14,085	30	81	1.8		649.3	649.3	649.4	0.1
V	15,797	14	21	7.0		654.1	654.1	654.1	0.0
W	15,810	19	52	2.9		655.9	655.9	656.0	0.1
X	16,167	18	58	2.6		656.6	656.6	656.7	0.1
Y	16,779	14	30	5.1		658.3	658.3	658.4	0.1

[1] Feet above confluence with Rush Creek

[2] Elevation computed without consideration of overflow from Rush Creek

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI

(ALL JURISDICTIONS)

FLOODWAY DATA

DEWEERD DRAIN

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
DEWEERD DRAIN (CONTINUED)									
Z	17,168	21	61	2.5		659.7	659.7	659.7	0.0
AA	17,594	21	57	2.6		660.5	660.5	660.5	0.0

[1] Feet above confluence with Rush Creek

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

DEWEERD DRAIN

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
GRAND RIVER									
A	0.19	383	10,023	6.1		584.3	580.6[2]	580.6	0.0
B	0.38	417	11,698	5.2		584.3	580.9[2]	580.9	0.0
C	0.75	595	14,211	4.3		584.3	581.2[2]	581.2	0.0
D	0.98	668	14,500	4.2		584.3	581.3[2]	581.3	0.0
E	1.16	473	11,766	4.8		584.3	581.4[2]	581.4	0.0
F	1.57	732	13,209	4.2		584.3	581.9[2]	581.9	0.0
G	2.13	595	12,291	4.6		584.3	582.3[2]	582.3	0.0
H	2.47	505	9,193	6.1		584.3	582.5[2]	582.5	0.0
I	2.51	523	9,674	5.8		584.3	582.7[2]	582.7	0.0
J	2.55	463	10,151	5.5	59	584.3	582.9[2]	582.9	0.0
K	2.64	887	13,049	4.3		584.3	583.2[2]	583.2	0.0
L	2.91	1,791	16,757	3.3		584.3	583.7[2]	583.7	0.0
M	3.28	3,042	26,556	2.3		584.3	584.1[2]	584.1	0.0
N	4.00	3,900	33,780	1.8		584.6	584.6	584.6	0.0
O	4.38	3,925	30,426	2.0		584.9	584.9	584.9	0.0
P	4.75	2,467	22,422	2.7		585.2	585.2	585.2	0.0
Q	5.17	3,586	31,809	1.9		585.6	585.6	585.6	0.0
R	5.53	2,920	26,717	2.3		585.8	585.8	585.8	0.0
S	6.21	2,100	24,982	2.4		586.3	586.3	586.3	0.0
T	6.45	2,964	27,565	2.2		586.5	586.5	586.5	0.0
U	6.97	3,178	28,956	2.1		587.0	587.0	587.0	0.0
V	7.38	3,322	28,641	2.1		587.3	587.3	587.3	0.0
W	7.97	3,382	29,203	3.4		587.8	587.8	587.9	0.1
X	9.60	3,179	27,264	4.4		588.5	588.5	588.6	0.1
Y	11.30	4,039	38,831	3.7		589.8	589.8	589.9	0.1

[1] Miles above mouth at Lake Michigan

[2] Elevation computed without consideration of backwater effects from Lake Michigan

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

GRAND RIVER

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
GRAND RIVER (CONTINUED)									
Z	12.32	2,230	23,752	5.0		590.7	590.7	590.8	0.1
AA	13.85	1,415	17,905	5.1		592.5	592.5	592.6	0.1
AB	14.91	2,926	37,421	3.7		593.8	593.8	593.9	0.1
AC	16.09	3,472	38,601	2.8		594.4	594.4	594.5	0.1
AD	17.13	3,014	38,977	3.5		594.7	594.7	594.8	0.1
AE	18.38	1,888	27,029	3.7		595.2	595.2	595.3	0.1
AF	19.06	2,253	22,702	5.3		595.5	595.5	595.6	0.1
AG	19.89	2,529	30,035	3.5		596.6	596.6	596.7	0.1
AH	20.97	1,496	23,936	3.6		597.1	597.1	597.2	0.1
AI	22.19	1,949	26,496	3.9		597.7	597.7	597.8	0.1
AJ	23.19	2,402	28,698	4.6		598.2	598.2	598.3	0.1
AK	24.28	2,200	29,637	3.6		598.8	598.8	598.9	0.1
AL	25.12	1,560	17,716	3.3		599.4	599.4	599.5	0.1
AM	25.24	1,564	23,190	2.5		599.7	599.7	599.8	0.1
AN	25.40	1,843	24,983	2.3		599.8	599.8	599.9	0.1
AO	25.80	1,537	25,058	2.3		600.1	600.1	600.2	0.1
AP	26.11	1,587	27,873	2.1		600.4	600.4	600.4	0.0
AQ	26.72	2,485	37,364	1.6		600.8	600.8	600.9	0.1
AR	27.08	1,619	23,299	2.5		600.9	600.9	601.0	0.1
AS	27.77	2,310	24,788	2.3		601.5	601.5	601.6	0.1
AT	28.27	2,139	27,039	2.1		601.8	601.8	601.9	0.1
AU	28.71	1,783	24,677	2.3		602.1	602.1	602.2	0.1
AV	28.99	1,731	27,318	2.1		602.4	602.4	602.4	0.0
AW	29.25	1,830	26,894	2.2		602.4	602.4	602.5	0.1

[1] Miles above mouth at Lake Michigan

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

GRAND RIVER

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
GRAND RIVER (CONTINUED)									
AX	29.65	3,135	43,112	1.4		602.6	602.6	602.7	0.1
AY	30.10	4,349	46,579	1.2		603.2	603.2	603.2	0.0
AZ	30.43	4,650	42,440	1.3		603.3	603.3	603.3	0.0
BA	30.61	4,070	44,240	1.3		603.4	603.4	603.4	0.0
BB	30.95	4,320	45,851	1.2		603.4	603.4	603.4	0.0
BC	31.37	3,450	29,983	1.9		603.5	603.5	603.5	0.0
BD	31.64	2,620	31,438	1.8		603.7	603.7	603.7	0.0
BE	32.16	2,520	29,926	1.9		603.9	603.9	603.9	0.0
BF	32.37	2,800	31,102	1.8		604.1	604.1	604.1	0.0
BG	32.65	3,450	39,790	1.4		604.2	604.2	604.2	0.0
BH	33.05	2,295	33,362	1.7		604.3	604.3	604.3	0.0

[1] Miles above mouth at Lake Michigan

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

GRAND RIVER

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
HAGER CREEK									
A	1,055	154	120	1.0		636.3	636.3	636.4	0.1
B	1,647	14	33	3.5		636.9	636.9	637.0	0.1
C	2,070	11	28	4.0	43	641.4	641.4	641.4	0.0

[1] Feet above confluence with Comstock Drain

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

HAGER CREEK

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
HARLEM EXT. DRAIN									
A	0	63	121	7.9		584.3	581.2[2]	581.2	0.0
B	180	35	136	7.0		584.3	583.0[2]	583.0	0.0
C	681	1,035	2,817	0.3		584.3	584.2[2]	584.2	0.0
D	2,631	289	776	1.1		584.4	584.4	584.4	0.0
E	3,175	38	126	7.0		585.4	585.4	585.4	0.0
F	3,976	577	1,334	0.7		586.3	586.3	586.3	0.0
G	5,576	425	640	1.4		587.3	587.3	587.3	0.0
H	6,607	28	114	7.7		589.7	589.7	589.7	0.0
I	6,708	228	719	1.0		590.9	590.9	590.9	0.0
J	8,958	376	505	1.4		591.8	591.8	591.8	0.0
K	11,508	57	217	2.7	128	596.6	596.6	596.6	0.0
HARLEM DRAIN									
L	11,545	30	106	5.6		596.7	596.7	596.8	0.1
M	11,646	100	245	2.4		597.3	597.3	597.3	0.0
N	12,916	128	165	3.6		598.8	598.8	598.8	0.0
O	13,988	43	151	3.9		600.8	600.8	600.8	0.0
P	15,088	32	114	5.2		603.1	603.1	603.1	0.0
Q	15,339	34	108	5.5		604.5	604.5	604.5	0.0
R	15,440	41	177	3.3		605.0	605.0	605.0	0.0
S	16,165	61	185	3.2		605.9	605.9	605.9	0.0
T	16,890	35	158	3.7		607.1	607.1	607.1	0.0
U	17,151	32	173	3.4		607.6	607.6	607.6	0.0
V	18,082	139	205	2.9		609.5	609.5	609.6	0.1

[1] Feet above mouth at Pine Creek Bay

[2] Elevation computed without consideration of backwater effects from Lake Macatawa

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

HARLEM EXT. DRAIN / HARLEM DRAIN

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
HARLEM DRAIN (CONTINUED)									
W	18,912	105	214	2.8		610.8	610.8	610.8	0.0
X	19,662	106	200	3.0		612.0	612.0	612.0	0.0
Y	20,412	111	228	2.6		613.2	613.2	613.2	0.0
Z	21,137	107	198	3.0		614.3	614.3	614.3	0.0
AA	21,862	165	208	2.8		615.6	615.6	615.6	0.0
AB	22,587	167	210	2.8		617.0	617.0	617.0	0.0
AC	23,312	212	535	1.1	41	617.6	617.6	617.6	0.0
AD	24,037	222	298	2.0		618.0	618.0	618.0	0.0
AE	24,762	42	135	4.4		619.5	619.5	619.5	0.0
AF	24,912	86	170	3.5		620.1	620.1	620.1	0.0

[1] Feet above mouth at Pine Creek Bay

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

HARLEM DRAIN

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
HUIZENGA INTERCOUNTY DRAIN									
A	452	230	547	1.7		605.7	603.4[2]	603.5	0.1
B	477	230	511	1.8		605.7	603.4[2]	603.5	0.1
C	730	37	134	6.7		605.7	603.3[2]	603.4	0.1
D	757	91	257	3.5		605.7	605.3[2]	605.4	0.1
E	1,007	130	324	2.8		605.7	605.7[2]	605.7	0.0
F	1,327	30	144	6.2		606.1	606.1	606.1	0.0
G	1,396	90	198	4.5		607.0	607.0	607.1	0.1
H	1,739	145	408	2.2		608.1	608.1	608.2	0.1
I	2,056	142	614	1.5		608.3	608.3	608.4	0.1
J	2,358	420	773	1.2		608.8	608.8	608.9	0.1
K	4,150	42	125	8.8		608.8[3]	608.8[3]	608.9[3]	0.1
L	4,210	96	260	4.2		612.1	612.1	612.2	0.1
M	4,335	42	166	6.6		612.1	612.1	612.2	0.1
N	4,410	107	391	2.8		614.4	614.4	614.5	0.1
O	4,587	90	398	2.8		614.5	614.5	614.6	0.1
P	5,738	35	131	8.4		615.1	615.1	615.1	0.0
Q	5,864	176	240	4.8		616.4	616.4	616.4	0.0

[1] Feet above confluence with Rush Creek
[2] Elevation computed without consideration of backwater effects from Rush Creek
[3] Elevation computed at downstream cross section applied to eliminate drawdown

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

HUIZENGA INTERCOUNTY DRAIN

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
HUNTERS CREEK									
A	400	124	383	3.3		615.8	615.8	615.8	0.0
B	1,400	325	821	1.5		617.7	617.7	617.8	0.1
C	2,690	220	591	2.1		619.4	619.4	619.5	0.1
D	3,445	120	536	2.4		620.7	620.7	620.7	0.0
E	3,661	70	233	2.9		621.6	621.6	621.6	0.0
F	3,976	14	88	7.6		622.2	622.2	622.2	0.0
G	4,077	122	378	1.8		623.4	623.4	623.4	0.0
H	4,727	140	321	2.1		623.8	623.8	623.8	0.0
I	5,477	113	249	2.7		626.2	626.2	626.2	0.0
J	6,547	107	456	1.5	83	629.6	629.6	629.6	0.0
K	7,837	255	456	1.5		632.9	632.9	632.9	0.0
L	8,687	116	330	2.0		635.8	635.8	635.8	0.0
M	8,945	184	354	1.9	57	636.8	636.8	636.8	0.0
N	9,411	243	365	1.8		639.4	639.4	639.4	0.0

[1] Feet above confluence with Noordeloos Creek

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

HUNTERS CREEK

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
KNIGHT INTERCOUNTY DRAIN									
A	78	180	405	2.2		645.6	645.6	645.7	0.1
B	829	155	435	2.0		646.3	646.3	646.4	0.1
C	1,301	217	487	1.8		646.8	646.8	646.9	0.1
D	1,453	44	147	5.8		646.9	646.9	646.9	0.0
E	1,529	43	235	3.6		649.5	649.5	649.5	0.0
F	1,621	195	1,042	0.8		650.0	650.0	650.0	0.0
G	1,932	118	594	1.4		650.0	650.0	650.0	0.0
H	2,159	210	929	0.9		650.0	650.0	650.1	0.1
I	3,195	246	916	0.9		650.3	650.3	650.4	0.1
J	3,905	362	1,018	0.8		650.5	650.5	650.6	0.1
K	4,116	348	744	1.1		650.6	650.6	650.7	0.1

[1] Feet above confluence with Bliss Creek Intercounty Drain

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

KNIGHT INTERCOUNTY DRAIN

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
MACATAWA RIVER									
A	0	418	5,371	3.2		584.3	579.5[2]	579.5	0.0
B	2,086	139	1,790	8.9		584.3	580.3[2]	580.3	0.0
C	5,100	1,293	4,460	4.0		584.3	582.6[2]	582.6	0.0
D	6,400	396	2,189	6.0		584.3	583.9[2]	583.9	0.0
E	7,400	175	1,534	8.5		585.8	585.8	585.8	0.0
F	8,300	317	2,787	4.7		587.6	587.6	587.7	0.1
G	13,718	770	5,199	2.9		593.7	593.7	593.8	0.1
BLACK CREEK OF ZEELAND DRAIN									
H	15,348	974	8,979	1.7		594.3	594.3	594.4	0.1
I	17,938	1,510	14,022	1.1		596.1	596.1	596.2	0.1
J	19,237	1,034	12,267	1.2		596.3	596.3	596.3	0.0
K	19,997	987	7,371	2.0		596.6	596.6	596.6	0.0
L	21,378	912	10,745	1.4		596.9	596.9	597.0	0.1
M	24,616	863	9,206	1.3		597.0	597.0	597.1	0.1
N	25,971	1,125	11,315	1.0		597.1	597.1	597.1	0.0
O	26,906	1,154	8,693	1.3		597.2	597.2	597.2	0.0
P	27,856	1,072	9,383	1.2		597.2	597.2	597.3	0.1
Q	30,279	973	7,449	1.3		598.5	598.5	598.5	0.0
R	31,259	579	2,811	3.3		598.5	598.5	598.5	0.0
S	32,109	916	5,890	1.9		599.0	599.0	599.1	0.1
T	32,969	531	4,347	2.2		599.2	599.2	599.3	0.1
U	34,535	1,189	9,891	0.9		600.4	600.4	600.5	0.1

[1] Feet above mouth at Lake Macatawa

[2] Elevation computed without consideration of backwater effects from Lake Macatawa

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

MACATAWA RIVER / BLACK CREEK OF ZEELAND DRAIN

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
BLACK CREEK OF ZEELAND DRAIN (CONTINUED)									
V	36,445	1,687	9,318	1.0		600.5	600.5	600.6	0.1
W	37,620	954	5,328	1.7		600.5	600.5	600.6	0.1
X	38,609	784	4,165	2.2		601.9	601.9	602.0	0.1
Y	45,691	668	3,402	5.9		603.4	603.4	603.4	0.0
Z	45,981	1,089	7,407	3.3		605.9	605.9	605.9	0.0
AA	50,177	2,837	12,018	0.4		606.4	606.4	606.4	0.0
AB	59,993	250	1,851	3.1		606.4	606.4	606.4	0.0
AC	61,319	435	2,841	0.8		606.9	606.9	606.9	0.0
AD	62,329	436	3,008	0.8		607.3	607.3	607.3	0.0
AE	63,169	1,113	5,003	0.5		607.3	607.3	607.3	0.0

[1] Feet above mouth at Lake Macatawa

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

BLACK CREEK OF ZEELAND DRAIN

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
MEADOWBROOK DRAIN									
A	635	260	371	1.1		615.7	614.8[2]	614.9	0.1
B	851	280	336	1.2		615.7	614.8[2]	614.9	0.1
C	2,146	252	516	0.9		615.7	615.0[2]	615.1	0.1
D	2,533	113	221	1.8		615.7	615.1[2]	615.2	0.1
E	3,043	173	306	1.3		615.7	615.6[2]	615.6	0.0
F	3,927	212	649	0.6		618.4	618.4	618.5	0.1
G	4,466	200	789	0.5		618.4	618.4	618.5	0.1

[1] Feet above confluence with Bliss Creek Intercounty Drain
[2] Elevation computed without consideration of backwater effects from Bliss Creek Intercounty Drain

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

MEADOWBROOK DRAIN

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
NOORDELOOS CREEK									
A	1,875	230	712	3.8		596.9	589.9[2]	589.9	0.0
B	2,658	220	1,102	2.4		596.9	592.0[2]	592.0	0.0
C	3,743	227	724	3.7		596.9	592.4[2]	592.4	0.0
D	4,608	400	1,395	1.9		596.9	593.6[2]	593.6	0.0
E	6,404	120	609	4.4		596.9	595.7[2]	595.7	0.0
F	6,909	430	1,581	1.7		596.9	596.4[2]	596.4	0.0
G	7,564	505	1,980	1.4		596.9	596.6[2]	596.6	0.0
H	8,204	276	881	3.0		596.9	596.8[2]	596.8	0.0
I	10,687	26	231	12.6		600.5	600.5	600.5	0.0
J	10,837	130	1,048	2.6		603.6	603.6	603.6	0.0
K	10,997	32	496	5.4		605.9	605.9	605.9	0.0
L	11,207	130	1,243	2.2		606.5	606.5	606.5	0.0
M	11,485	62	735	3.6		608.1	608.1	608.1	0.0
N	11,600	280	3,378	0.6		608.4	608.4	608.4	0.0
O	11,950	405	3,985	0.5		608.4	608.4	608.4	0.0
P	12,052	417	1,122	1.8		608.4	608.4	608.4	0.0
Q	12,137	475	4,831	0.4		608.4	608.4	608.4	0.0
R	13,297	415	4,223	0.5		608.5	608.5	608.5	0.0
S	14,757	430	2,612	0.8		608.5	608.5	608.5	0.0
T	16,467	510	1,794	1.1		608.7	608.7	608.7	0.0
U	18,087	520	1,543	1.3		609.2	609.2	609.2	0.0
V	19,352	335	978	2.1		609.6	609.6	609.6	0.0
W	21,097	552	1,446	1.4	26	610.4	610.4	610.4	0.0
X	22,232	403	1,848	1.1	232	610.7	610.7	610.7	0.0

[1] Feet above confluence with Black Creek of Zeeland Drain

[2] Elevation computed without consideration of backwater effects from Black Creek of Zeeland Drain

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

NOORDELOOS CREEK

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
NOORDELOOS CREEK (CONTINUED)									
Y	23,182	72	311	6.5		610.7	610.7	610.7	0.0
Z	23,822	102	513	3.9	30	613.1	613.1	613.1	0.0
AA	23,933	35	276	7.3		613.3	613.3	613.3	0.0
AB	24,023	230	701	2.9		614.3	614.3	614.3	0.0
AC	24,453	215	717	2.8		614.8	614.8	614.8	0.0
AD	25,073	219	493	1.7		615.6	615.6	615.6	0.0
AE	26,243	175	345	2.4		616.6	616.6	616.6	0.0
AF	27,633	144	444	1.8		618.2	618.2	618.2	0.0
AG	28,818	145	400	2.0		619.5	619.5	619.5	0.0
AH	30,153	68	188	4.3		622.2	622.2	622.2	0.0
AI	30,903	150	361	2.3		624.0	624.0	624.0	0.0
AJ	32,318	150	272	3.0		626.8	626.8	626.8	0.0
AK	33,168	91	395	2.1	50	628.4	628.4	628.4	0.0
AL	33,434	30	130	6.2		629.1	629.1	629.1	0.0

[1] Feet above confluence with Black Creek of Zeeland Drain

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

NOORDELOOS CREEK

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
NORTHWEST BRANCH OF RUSH CREEK									
A	210	27	73	4.7		614.8	612.2[2]	612.3	0.1
B	931	30	97	3.5		614.8	613.8[2]	613.8	0.0
C	1,042	65	207	1.7		616.6	616.6	616.7	0.1
D	1,348	115	397	0.9		616.7	616.7	616.8	0.1
E	1,834	39	109	3.1		616.7	616.7	616.8	0.1
F	2,319	22	78	4.4		617.9	617.9	617.9	0.0
G	2,455	60	223	1.5		621.3	621.3	621.4	0.1
H	2,627	67	176	1.3		621.4	621.4	621.5	0.1
I	3,126	26	79	4.3		622.3	622.3	622.3	0.0
J	3,730	37	214	1.6		626.2	626.2	626.2	0.0
K	4,005	47	227	1.5		626.2	626.2	626.3	0.1

[1] Feet above confluence with Rush Creek

[2] Elevation computed without consideration of backwater effects from Rush Creek

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

NORTHWEST BRANCH OF RUSH CREEK

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
OTTAWA CREEK & EXT. DRAIN									
A	3,437	176	180	3.8		599.1	593.4[2]	593.4	0.0
B	4,312	114	185	3.7		599.1	595.9[2]	595.9	0.0
C	4,785	87	210	3.3		599.1	597.1[2]	597.1	0.0
D	5,172	110	866	0.8	25	605.1	605.1	605.1	0.0
E	5,746	183	1,085	0.6	37	605.2	605.2	605.2	0.0
F	6,622	125	809	0.8	46	605.2	605.2	605.2	0.0
G	7,672	125	150	4.6		606.3	606.3	606.3	0.0
H	8,383	110	228	3.0		609.0	609.0	609.0	0.0
I	9,440	30	90	7.6		612.0	612.0	612.0	0.0
J	10,769	64	117	4.5		619.1	619.1	619.1	0.0
K	11,515	178	163	3.2		626.1	626.1	626.1	0.0
L	11,838	60	288	1.8		630.9	630.9	630.9	0.0
M	12,124	174	657	0.8		631.0	631.0	631.0	0.0
N	12,514	48	79	6.6		632.3	632.3	632.3	0.0
OTTAWA DRAIN									
O	13,004	60	445	1.2		640.1	640.1	640.1	0.0
P	14,462	44	103	5.1	59	643.0	643.0	643.0	0.0
CURRY DRAIN									
Q	16,331	80	127	4.1		654.1	654.1	654.1	0.0
R	16,594	59	157	3.3		655.1	655.1	655.1	0.0
S	16,791	66	174	3.0		655.6	655.6	655.6	0.0
T	17,289	98	139	3.7		656.2	656.2	656.2	0.0

[1] Feet above confluence with Grand River

[2] Elevation computed without consideration of backwater effects from Grand River

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

OTTAWA CREEK & EXT. DRAIN / OTTAWA CREEK / CURRY DRAIN

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
RUSH CREEK									
A	3,187	150/90[2]	941	4.9		604.4	599.6[3]	599.7	0.1
B	3,909	240	983	4.7		604.4	600.9[3]	600.9	0.0
C	4,197	291	942	4.9		604.4	603.7[3]	603.8	0.1
D	4,532	303	2,231	2.1		605.8	605.8	605.9	0.1
E	6,187	480	1,780	2.5		606.2	606.2	606.3	0.1
F	6,542	530	2,405	1.8		606.5	606.5	606.6	0.1
G	7,097	375	2,196	2.0		606.6	606.6	606.7	0.1
H	8,296	883	5,160	0.8		606.7	606.7	606.8	0.1
I	9,090	1,250	6,707	0.7		606.7	606.7	606.8	0.1
J	10,473	743	3,163	0.9		606.7	606.7	606.8	0.1
K	11,121	668	2,010	1.4		606.7	606.7	606.8	0.1
L	12,342	1,250	7,355	0.4		606.8	606.8	606.9	0.1
M	13,093	1,030	6,065	0.5		606.8	606.8	606.9	0.1
N	13,966	445	2,537	1.1		606.8	606.8	606.9	0.1
O	14,796	440	1,652	1.7		606.8	606.8	606.9	0.1
P	14,983	438	801	3.4		607.6	607.6	607.7	0.1
Q	15,198	430	1,369	2.0		608.0	608.0	608.1	0.1
R	19,068	164	935	2.6		608.6	608.6	608.7	0.1
S	19,743	600	2,538	1.0		608.9	608.9	609.0	0.1
T	20,835	117	473	5.1		609.6	609.6	609.6	0.0
U	21,077	818	2,833	0.9		610.1	610.1	610.2	0.1
V	25,185	51	277	6.4		610.7	610.7	610.8	0.1
W	25,428	715	3,947	0.5		613.3	613.3	613.4	0.1
X	27,037	571	2,940	0.6		613.4	613.4	613.5	0.1

[1] Feet above confluence with Grand River
[2] Total width/width within Ottawa County
[2] Elevation computed without consideration of backwater effects from Grand River

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

RUSH CREEK

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
RUSH CREEK (CONTINUED)									
Y	28,368	149	435	4.1		613.4[2]	613.3	613.4	0.1
Z	28,482	50	265	6.6		613.4[2]	613.3	613.4	0.1
AA	28,849	293	938	1.9		614.5	614.5	614.5	0.0
AB	29,879	913	5,249	0.3		614.5	614.5	614.6	0.1
AC	30,619	853	4,793	0.3		614.5	614.5	614.6	0.1
AD	31,168	1,076	4,819	0.2		614.5	614.5	614.6	0.1
AE	33,156	584	3,048	0.3		614.5	614.5	614.6	0.1
AF	33,485	655	3,179	0.2		614.6	614.6	614.7	0.1
AG	34,570	1,150	4,603	0.2		614.6	614.6	614.7	0.1
AH	35,953	658	2,040	0.4		614.6	614.6	614.7	0.1

[1] Feet above confluence with Grand River

[2] Downstream elevation applied to eliminate drawdown

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

RUSH CREEK

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
SOUTH CHANNEL									
A[3]	0.00	227	3,217	1.6		584.3	581.4[2]	581.4	0.0
B[4]	0.19	161	1,272	3.9		584.3	581.4[2]	581.4	0.0
C	0.30	170	1,429	3.5		584.3	581.9[2]	581.9	0.0
D	0.40	150	1,015	4.9		584.3	582.0[2]	582.0	0.0
E[5]	0.46	225	1,769	2.8		584.3	582.4[2]	582.4	0.0
F[6]	0.55	266	1,635	3.1		584.3	582.7[2]	582.7	0.0
G	0.68	282	1,964	2.6		584.3	582.9[2]	582.9	0.0
H[7]	0.78	169	1,223	4.1		584.3	583.1[2]	583.1	0.0
I[8]	0.82	264	1,824	2.7		584.3	583.5[2]	583.5	0.0
J[9]	0.99	1,186	6,338	0.8		584.3	583.7[2]	583.7	0.0

[1] Miles above confluence with Grand River
[2] Elevation computed without consideration of backwater effects from Grand River
[3] Corresponds to Grand River Cross Section E
[4] Corresponds to Grand River Cross Section F
[5] Corresponds to Grand River Cross Section G
[6] Corresponds to Grand River Cross Section H
[7] Corresponds to Grand River Cross Section J
[8] Corresponds to Grand River Cross Section K
[9] Corresponds to Grand River Cross Section L

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

SOUTH CHANNEL

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
TROUT DRAIN									
A	1,317	19	36	3.9		612.6	612.6	612.6	0.0
B	1,484	18	66	2.0		613.5	613.5	613.5	0.0
C	1,585	18	21	6.2		614.3	614.3	614.3	0.0
D	1,982	51	80	1.6		615.9	615.9	616.0	0.1
E	2,254	44	113	1.2		616.0	616.0	616.1	0.1
F	2,407	282	331	0.3		616.3	616.3	616.4	0.1
G	3,889	19	48	1.9		616.5	616.5	616.5	0.0
H	3,929	20	54	1.7		616.5	616.5	616.6	0.1
I	5,468	13	21	1.7		617.3	617.3	617.3	0.0
J	5,640	8	18	2.0		617.4	617.4	617.4	0.0
K	5,680	12	38	0.9		619.7	619.7	619.7	0.0
L	6,954	6	6	5.8		623.2	623.2	623.2	0.0

[1] Feet above confluence with DeWeerd Drain

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

TROUT DRAIN

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
TULIP INTERCOUNTY DRAIN									
A	1,075	699	4,584	0.8		597.2	592.3[2]	592.3	0.0
B	1,304	64	207	5.0		597.2	593.4[2]	593.4	0.0
C	2,404	142	464	2.2		597.2	596.8[2]	596.8	0.0
D	2,869	102	195	5.3		597.9	597.9	597.9	0.0
E	4,179	124	365	2.8		601.9	601.9	601.9	0.0
F	5,579	45	200	5.1	39	604.8	604.8	604.8	0.0
G	6,659	66	206	5.0		609.4	609.4	609.4	0.0
H	7,639	74	192	5.3		614.0	614.0	614.0	0.0
I	8,829	79	275	3.7		619.2	619.2	619.3	0.1
J	10,199	75	244	4.2	40	623.3	623.3	623.4	0.1
K	11,199	180	460	2.2		624.7	624.7	624.7	0.0
L	12,409	53	257	4.0		625.8	625.8	625.8	0.0
M	12,469	46	210	4.9		625.8	625.8	625.8	0.0

[1] Feet above confluence with Black Creek of Zeeland Drain

[2] Elevation computed without consideration of backwater effects from Black Creek of Zeeland Drain

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

TULIP INTERCOUNTY DRAIN

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
UNNAMED TRIBUTARY 1 TO BUTTERMILK CREEK									
A	40	32	162	3.2		650.9	650.9	651.0	0.1
B	1,131	18	55	6.9		654.8	654.8	654.8	0.0
C	1,256	21	49	8.3		655.7	655.7	655.7	0.0
D	1,359	35	133	2.9		659.2	659.2	659.2	0.0
E	1,804	25	72	5.3		660.2	660.2	660.2	0.0
F	1,911	111	576	0.7		660.6	660.6	660.6	0.0
G	2,257	212	1,410	0.3		660.6	660.6	660.6	0.0
H	2,394	29	201	2.0		660.6	660.6	660.6	0.0
I	2,648	81	216	1.9		665.1	665.1	665.1	0.0
J	3,039	50	194	2.1		670.0	670.0	670.0	0.0

[1] Feet above confluence with Buttermilk Creek

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

UNNAMED TRIBUTARY 1 TO BUTTERMILK CREEK

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
UNNAMED TRIBUTARY 2 TO BUTTERMILK CREEK									
A	221	485	4,428	0.2		672.9	672.9	672.9	0.0
B	448	242	1,083	0.2		672.9	672.9	672.9	0.0
C	1,684	36	34	4.5		677.7	677.7	677.8	0.1
D	3,229	38	35	4.3		698.0	698.0	698.0	0.0
E	3,338	38	30	5.1		701.7	701.7	701.8	0.1

[1] Feet above confluence with Buttermilk Creek

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

UNNAMED TRIBUTARY 2 TO BUTTERMILK CREEK

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
VANS BYPASS									
A	288	19	183	0.1		618.4	618.4	618.5	0.1
B	474	10	83	0.3		618.4	618.4	618.5	0.1
C	1,235	45	259	0.1		619.2	619.2	619.3	0.1
D	1,498	60	205	0.1		619.2	619.2	619.3	0.1

[1] Feet above confluence with Bareman Drain

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

VANS BYPASS

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
WATSON DRAIN									
A	1,244	27	64	3.7		604.3	594.8[2]	594.8	0.0
B	1,344	50	94	2.6		604.3	595.2[2]	595.2	0.0
C	1,944	50	123	1.9		604.3	595.8[2]	595.8	0.0
D	2,265	20	42	5.7		604.3	597.0[2]	597.0	0.0
E	2,615	93	322	0.7		604.3	603.4[2]	603.4	0.0
F	2,915	100	224	0.7		604.3	603.4[2]	603.4	0.0
G	3,415	189	1,497	0.1		604.3	603.4[2]	603.4	0.0
H	3,596	7	44	3.7		604.3	604.0[2]	604.0	0.0
I	3,696	48	219	0.7		604.3	604.2[2]	604.2	0.0
J	5,446	300	325	0.3		604.3	604.3	604.3	0.0
K	6,446	163	514	0.1		604.3	604.3	604.3	0.0

[1] Feet above confluence with Grand River

[2] Elevation computed without consideration of backwater effects from Grand River

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI
(ALL JURISDICTIONS)

FLOODWAY DATA

WATSON DRAIN

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
WINDMILL CREEK									
A	42	149	355	3.1		592.6	582.8[2]	582.9	0.1
B	550	50	168	6.5		592.6	584.4[2]	584.5	0.1
C	790	26	120	9.2		592.6	587.8[2]	587.8	0.1
D	835	35	270	4.1		592.6	589.4[2]	589.4	0.0

[1] Feet above confluence with Macatawa River

[2] Elevation computed without consideration of backwater effects from Macatawa River

FEDERAL EMERGENCY MANAGEMENT AGENCY

OTTAWA COUNTY, MI

(ALL JURISDICTIONS)

FLOODWAY DATA

WINDMILL CREEK

TABLE 13